International Conference on Vetiver 7th

The Seventh International Conference on Vetiver (ICV-7)
29 May-1 June 2023, Chiang Mai, Thailand

Vetiver Grass Technology (VGT) for Infrastructure Protection and Disaster Mitigation: Challenges and Future Visions

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May 30, 2023

Outline of the Presentation

01

Background and Problem Statement

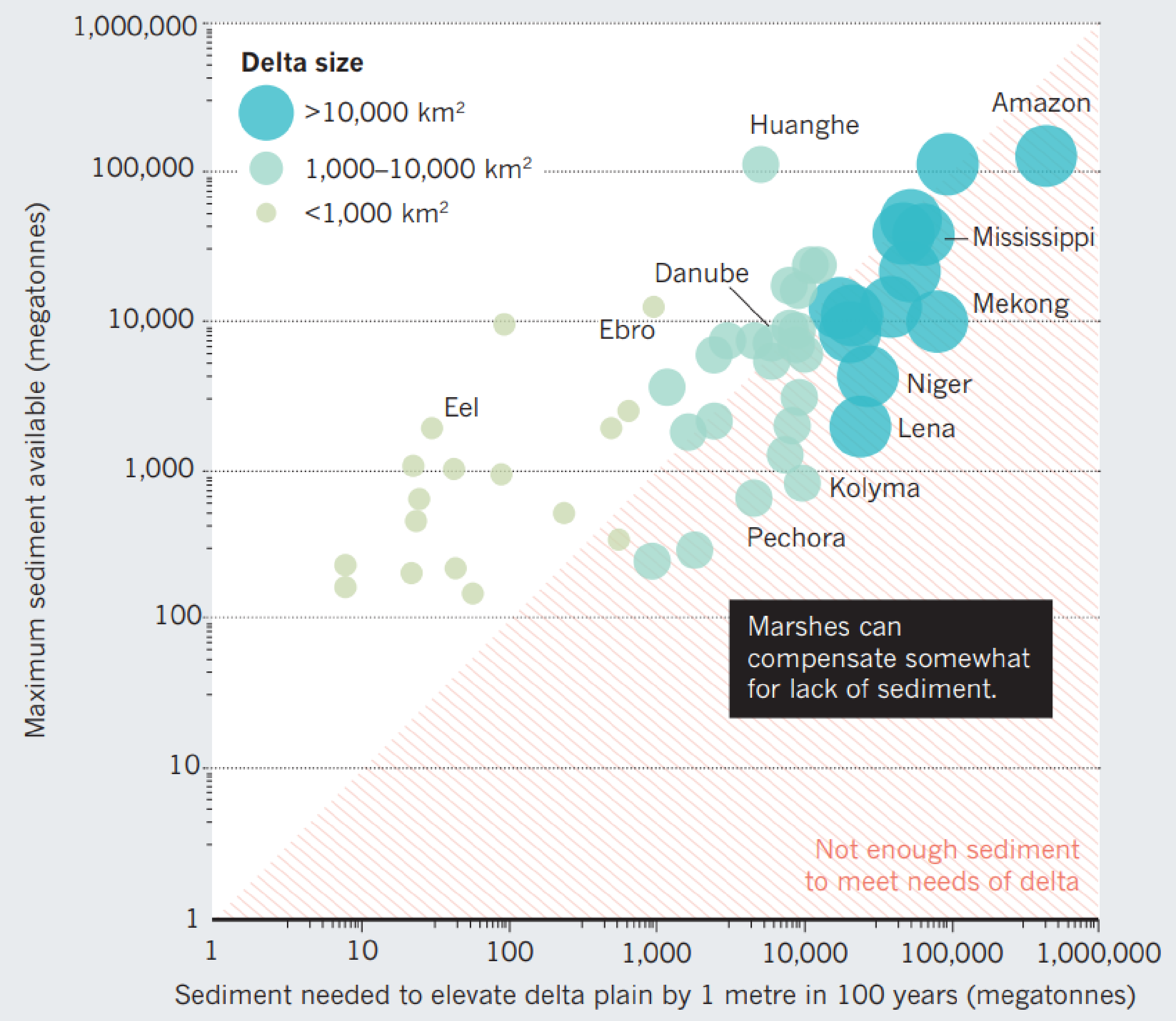
Relative Vulnerability of Coastal Deltas

Relative vulnerability of coastal deltas as shown by the indicative population potentially displaced by current sea-level trends to 2050 (Extreme = >1 million; High = 1 million to 50,000; Medium = 50,000 to 5,000; following Ericson et al., 2006).

Impacts of Climate Change on Deltas

Rise in the Sea Levels

By 2100, **land losses** from **rising sea levels** alone could reach 5% for higher deltas such as the Ganges–Brahmaputra, 30% for the Mekong, Nile and Yellow, and more than 80% for the lower Danube delta which will cause the displacement of about **0.5 billion people.** It is estimated that **17%** of Bangladesh will be submerged by 2050 which will trigger the displacement of about **20 million people.**



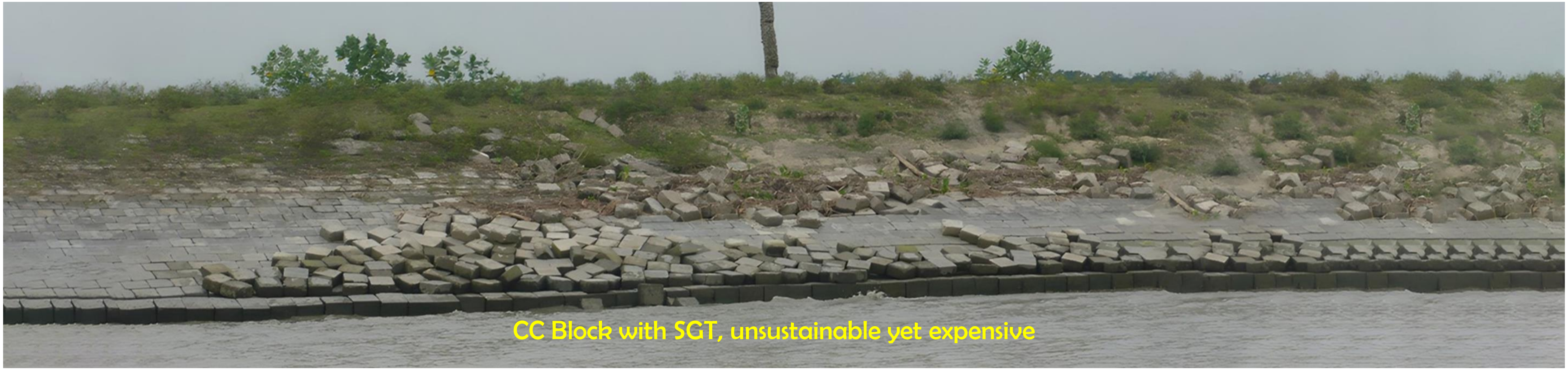
Giosan et al., 2014

River Erosion

Brahmaputra Gidari, Gaibandha, 2012
Photo: Dr. Tahsin Reza Hossain, BUET

www.thenewhumanitarian.org

Conventional Riverbank Protection



Char Land

A Typical *Char* (Hossain, 2018)

A Typical *Char* Village

Char means riverine island or mid-channel island, which emerges as a result of continuous accretion in the river bed commonly surrounded by surface water sources (Islam et al., 2014). Accretion of land is subjected to continual change, Erosion and Reformation.

Char Land

Haor (Swampy Land)

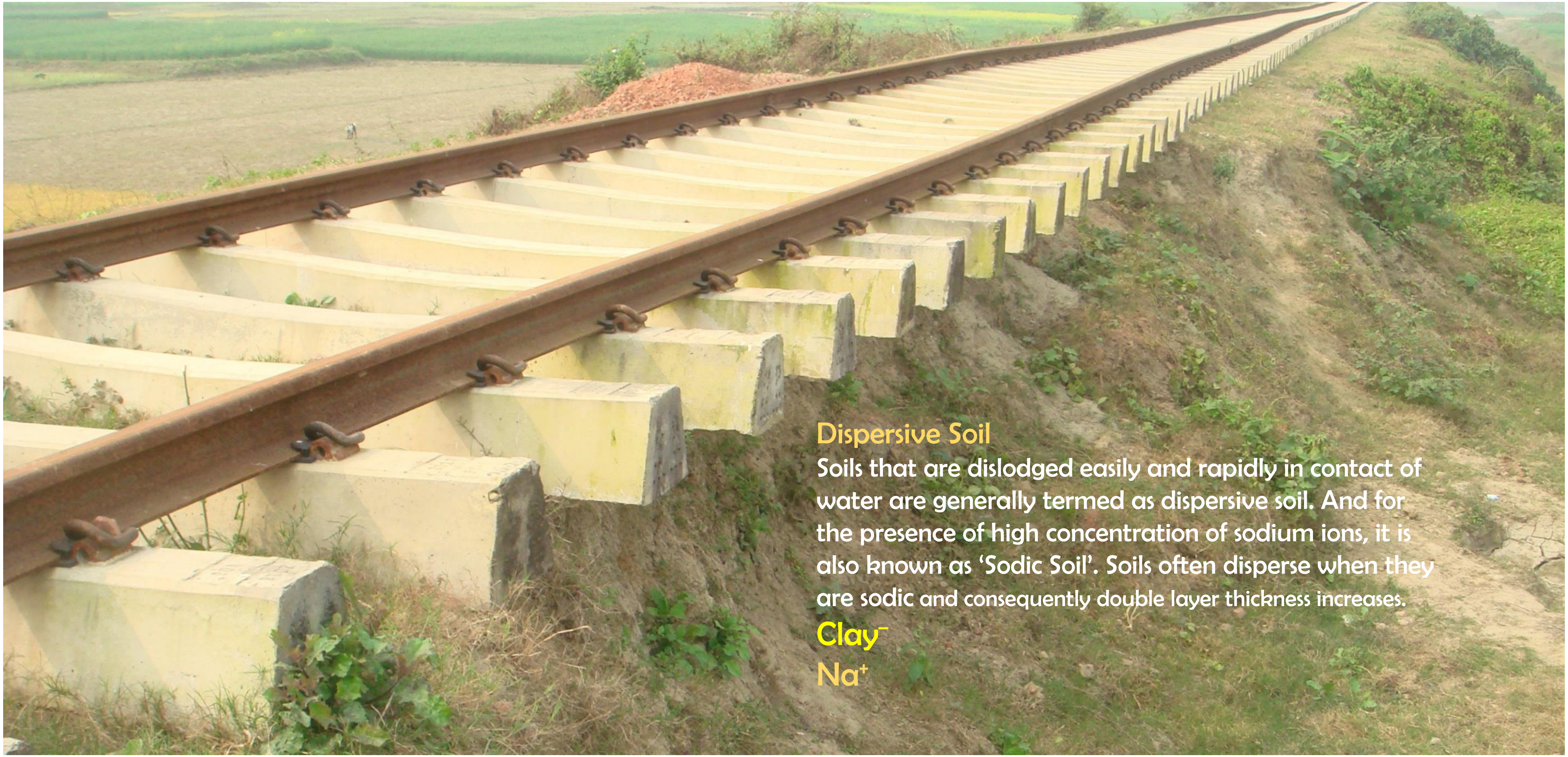
Haor is a swampy land that inundates annually during monsoon located in the north-eastern part of Bangladesh. During monsoon *haors* receive surface runoff from rivers and canals to become vast stretches of turbulent water.

Haor Infrastructure

Haor village protection using CC Block, SGT and toe wall. Costly and non-eco-friendly protection, also lacking durability.

Dykes and Embankments

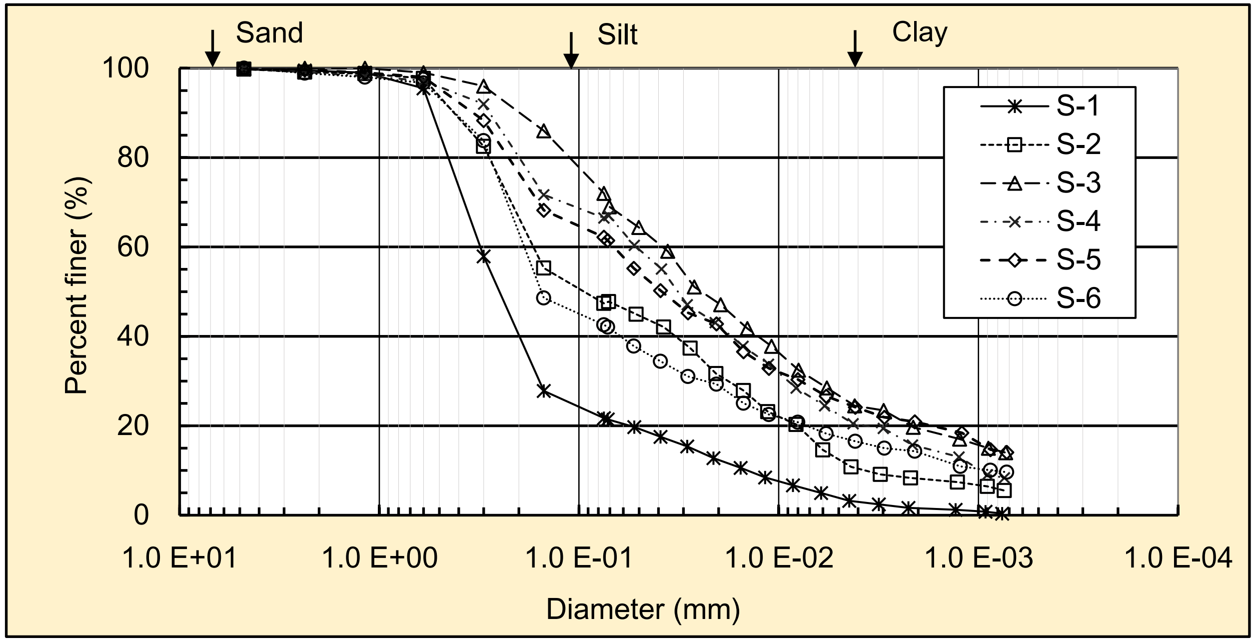
Rail Embankment



Dispersive Soil

Soils that are dislodged easily and rapidly in contact of water are generally termed as dispersive soil. And for the presence of high concentration of sodium ions, it is also known as ‘Sodic Soil’. Soils often disperse when they are sodic and consequently double layer thickness increases.

Hill Slopes

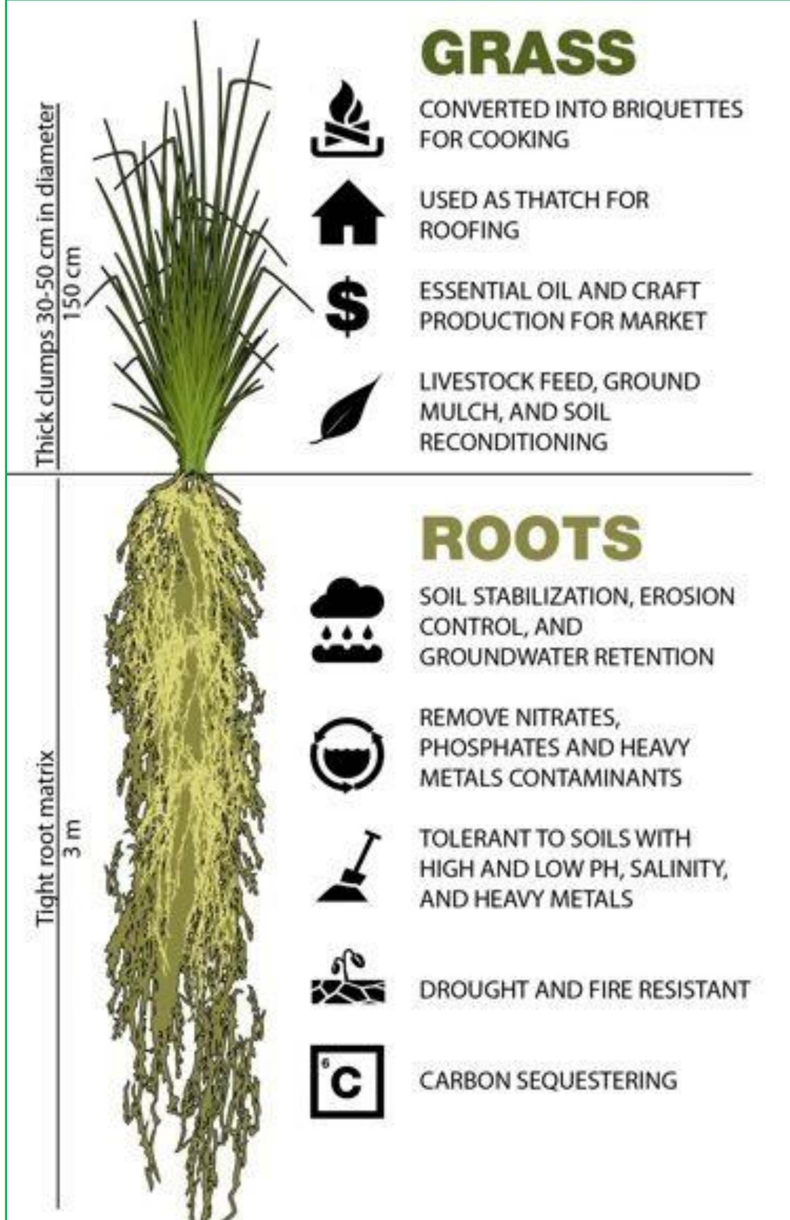


Landslide occurred in 2017 (Islam et al., 2021)

02

Research Gaps

Vetiver Grass



(www.pinterest.com)

Factors		Tolerance Limit
pH		3.0 to 10.5
Salinity		10 to 47.5 dS/m
Sodicity		up to 48% ESP
Temperature		−15°C to 55°C
Drought		up to 6 months
Submergence		3 to 4 months
Heavy Metal		(in mg/kg)
-	Arsenic	100–250
-	Cadmium	20–60
-	Copper	50–100
-	Chromium	200–600
-	Lead	>1 500
-	Mercury	>6
-	Nickel	100
-	Selenium	>74
-	Zinc	>750
Rainfall/Precipitation		250-5000 mm

Characteristics	Value
Tensile Strength of Root	75 MPa
Carbon Sequestration Capacity	15-150 ton C/ha/year

www.vetiver.org (Ziyuan Feng)

Carbon Sequestration of Vetiver and Other Grasses

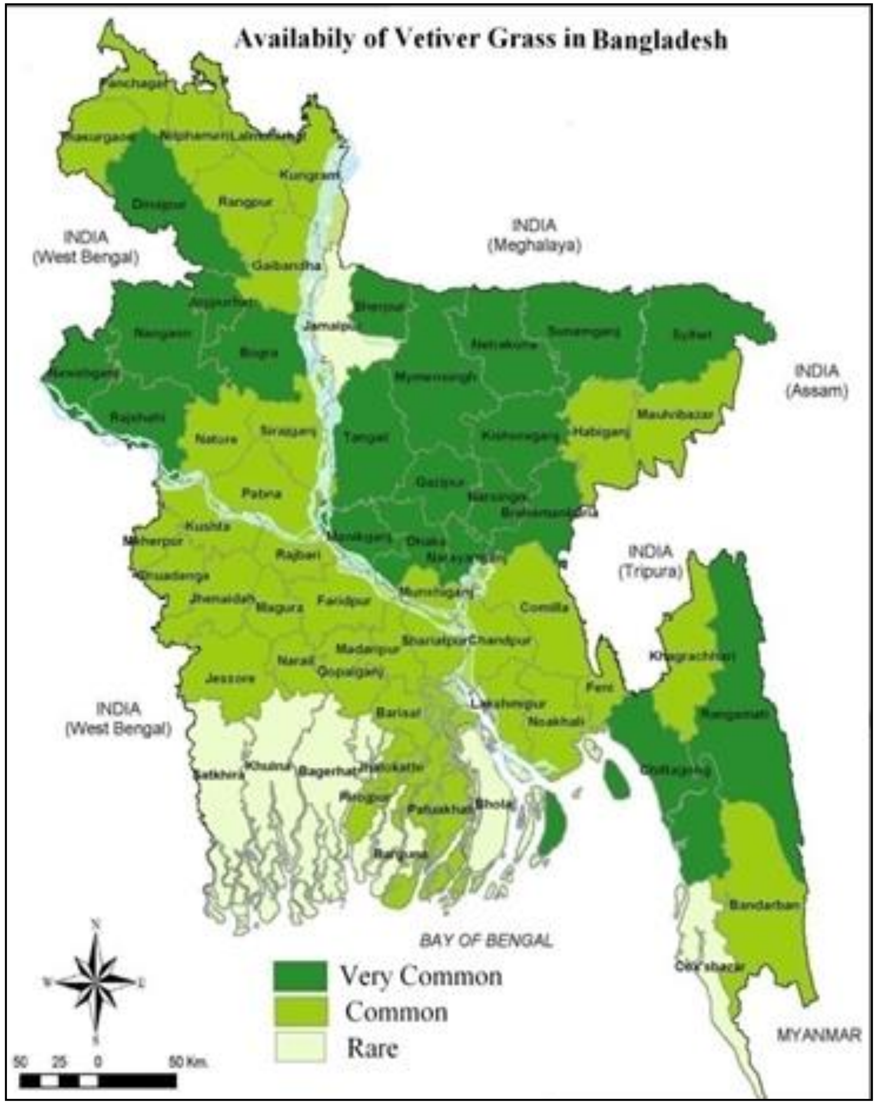
Sl. No.	Type of Grass	Sequestered Carbon	Reference
1	Vetiver (*Chrysopogon zizanioides*)	15.24 ton C/ha/year	Singh et al. (2014), Lakshmi and Sekhar (2020)
2	Lemongrass (*Cymbopogon citratus*)	5.38 ton C/ha/year	
3	Palmarosa (*Cymbopogon martini*)	6.14 ton C/ha/year	
4	Hybrid Napier	49.42 ton C/ha	Toppo et al. (2021)
5	Sudan Grass (*Sorghum × drummondii*)	42.36 ton C/ha	
6	Zoysiagrass (*Zoysia japonica*)	5.54± 0.21 ton C/ha/year	Hamido et al. (2016)
7	Bermuda Grass (*Cynodon dactylon*)	2.09± 0.1 ton C/ha/year	
8	Centipedegrass (*Eremochloa ophiuroides*)	4.23± 0.14 ton C/ha/year	
9	Turfgrasses	0.32-0.78 ton C/ha/year	Qian et al. (2010)
10	Deep rooted tropical grasses in South America	100-500 ton C/ha/year	Grimshaw (n.d.)
11	Vetiver (*Chrysopogon zizanioides*)	150 ton C/ha/year	
12	Vetiver (*Chrysopogon zizanioides*)	0.2 kg C/plant/year	www.vetiver.org

Carbon Sequestration: is the process of preventing CO_2 from entering the Earth's atmosphere;
Carbon Sink: the reservoirs that retain the CO_2.

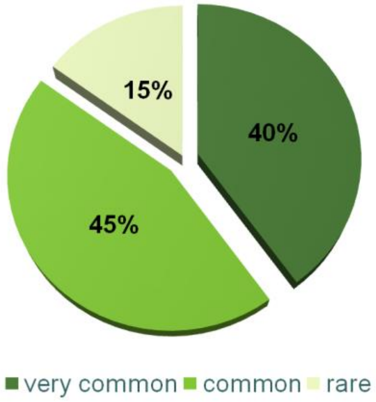
As a whole, it can be said that vetiver can sequester higher carbon than other common grasses. However, the reporting and the data varies significantly in the existing literature which emphasize the need for further research on this topic considering soil characteristics, geographical locations.

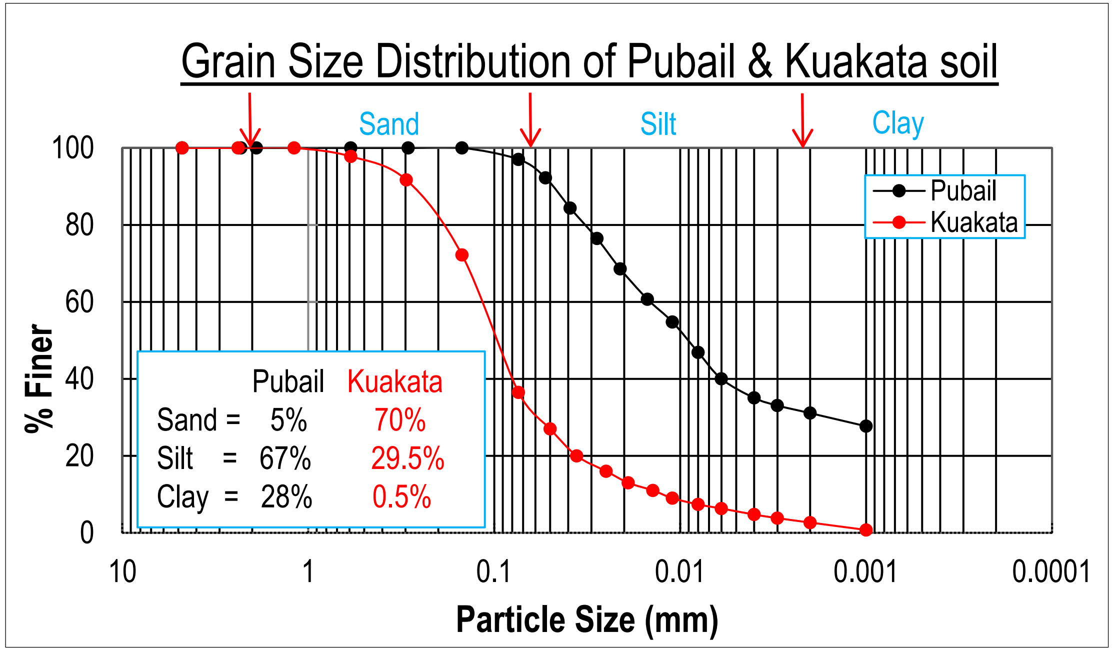
Commercial Uses of Vetiver

Native Habitats of Vetiver in Bangladesh

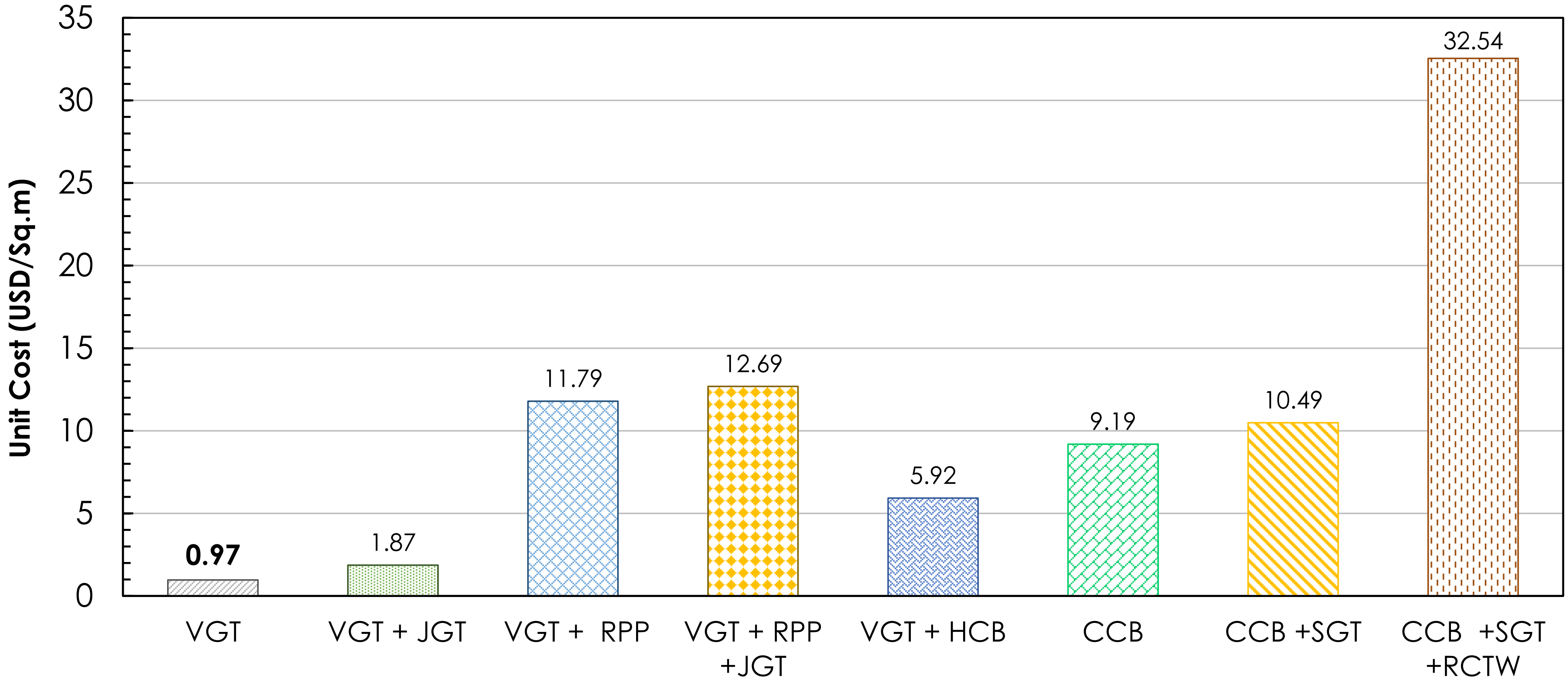


Thomas et al., 2002





VGT-A Low Cost Solution



Comparison of cost of VGT with other conventional practices and new techniques.
JGT: Jute geo-textile, RPP: Recycled Plastic Pin, CCB: Cement Concrete Block, HCB: Hollow Cement Concrete Block, SGT: Synthetic Geotextile, RCTW: Reinforced Concrete Retaining Wall

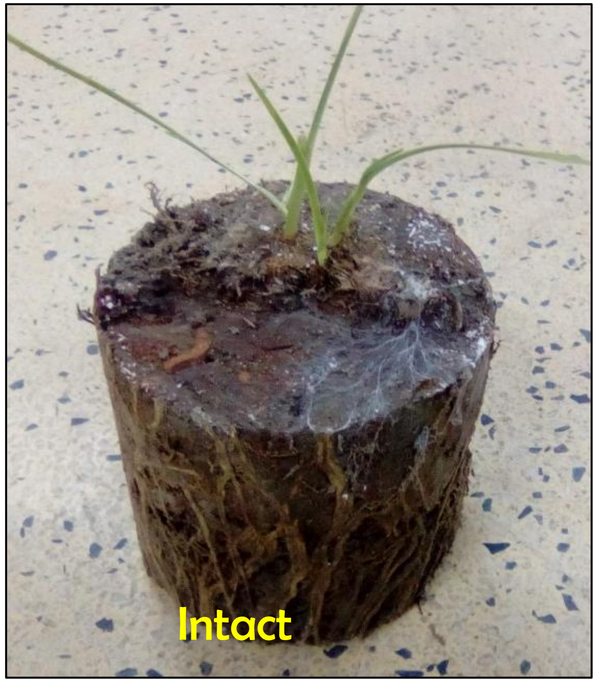
Research Gaps

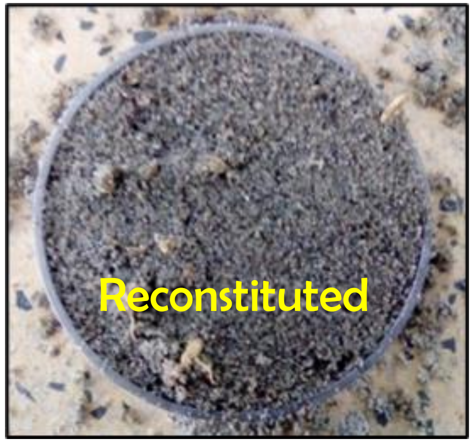
- Identification of vetiver species, local availability and growth of vetiver grass
- Tensile strength of vetiver root and shear strength parameters of rooted soil
- Development of instrument for the determination of in-situ shear strength of rooted soil
- Characterization of vetiver-planted subsoil
  - Roughness Co-efficient
  - Infiltration
  - Submergence
  - Wave Tolerance
- Mathematical modeling for root strength and shear strength of rooted-soil and numerical analysis of deformation and bearing capacity of vetiver rooted-ground
- Erosion and runoff reduction
- Development of diversified applications for ensuring public goods
- Phytoremediation of heavy metals from contaminated soils and water

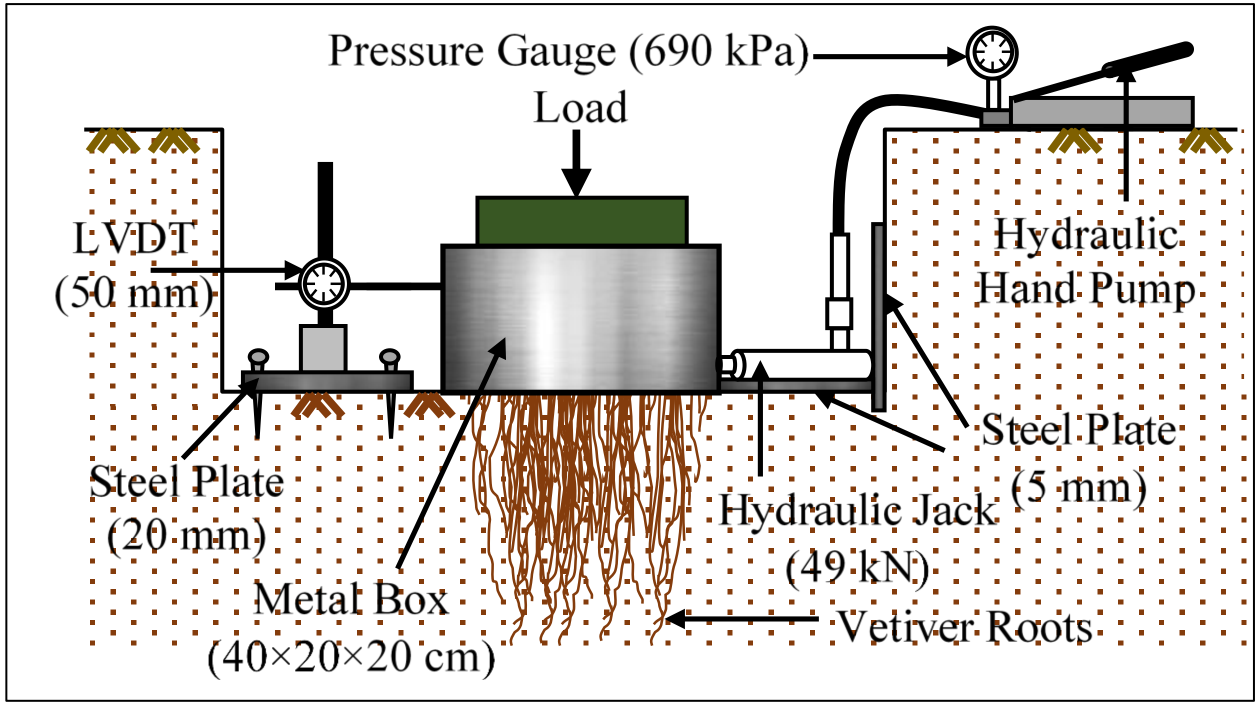
03

Research and Developments

Strength-Deformation Characteristics of Rooted-Soil





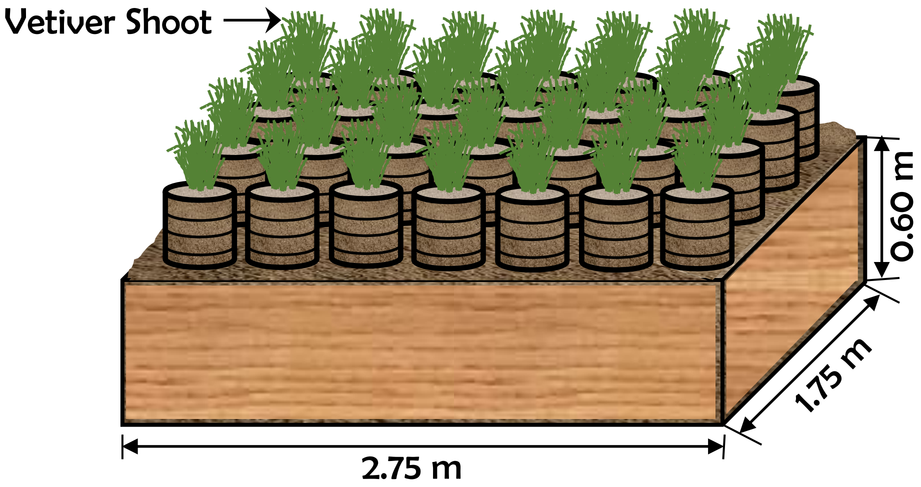


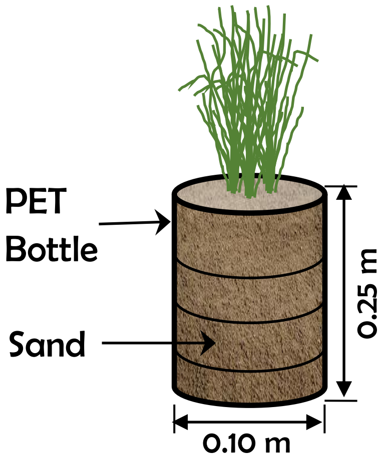
In-situ Test Setup (Islam et al., 2013)

The inclusion of vetiver roots in soil samples can significantly increase overall soil strength and cohesion c_u, but impact the angle of internal friction, ϕ variably depending on soil grain size, with optimum strength observed at specific root lengths.

(Islam et al., 2013; Hoque et al., 2021 and Badhon et al., 2021a)

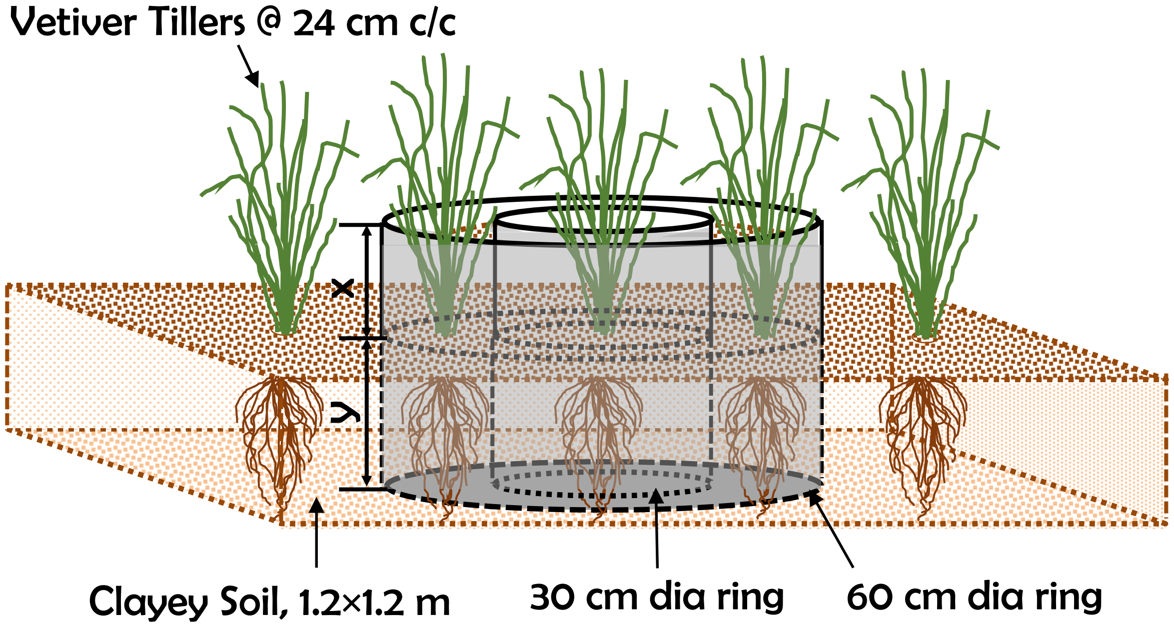
Growth Study in Sandy Soil





Vetiver can grow satisfactorily in various types of soils, including sandy soil and concrete dump, and across diverse geographical locations with low essential elements, in both acidic and alkaline environments, suggesting its potential use in soil stabilization and remediation (Badhon et al., 2021b).

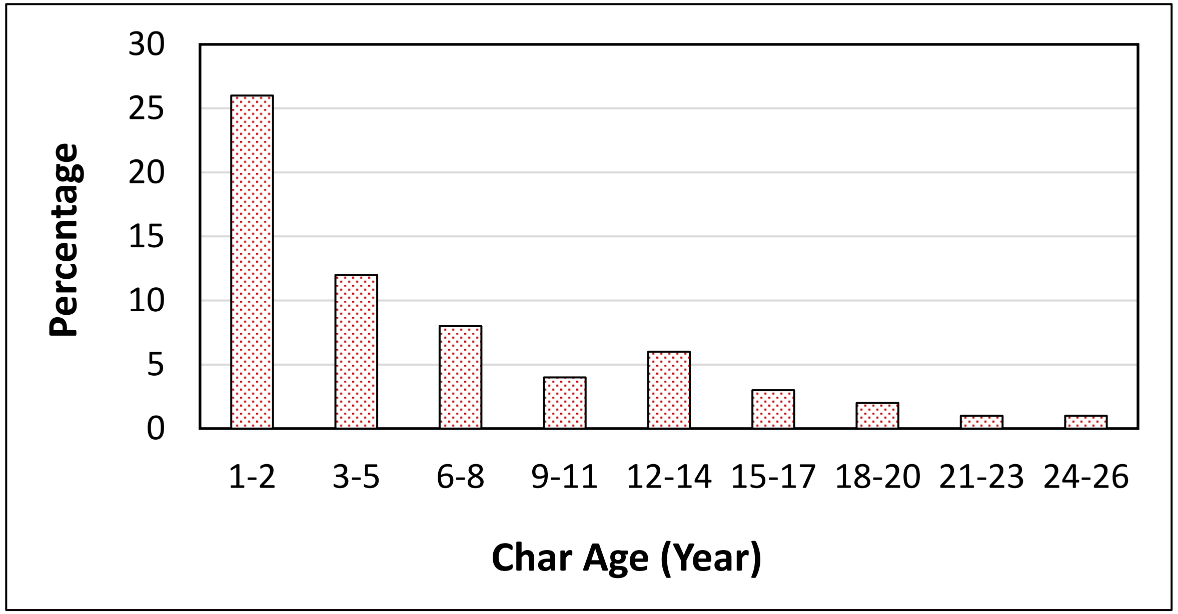
Infiltration Characteristics of Vetiver Planted Sub-soil



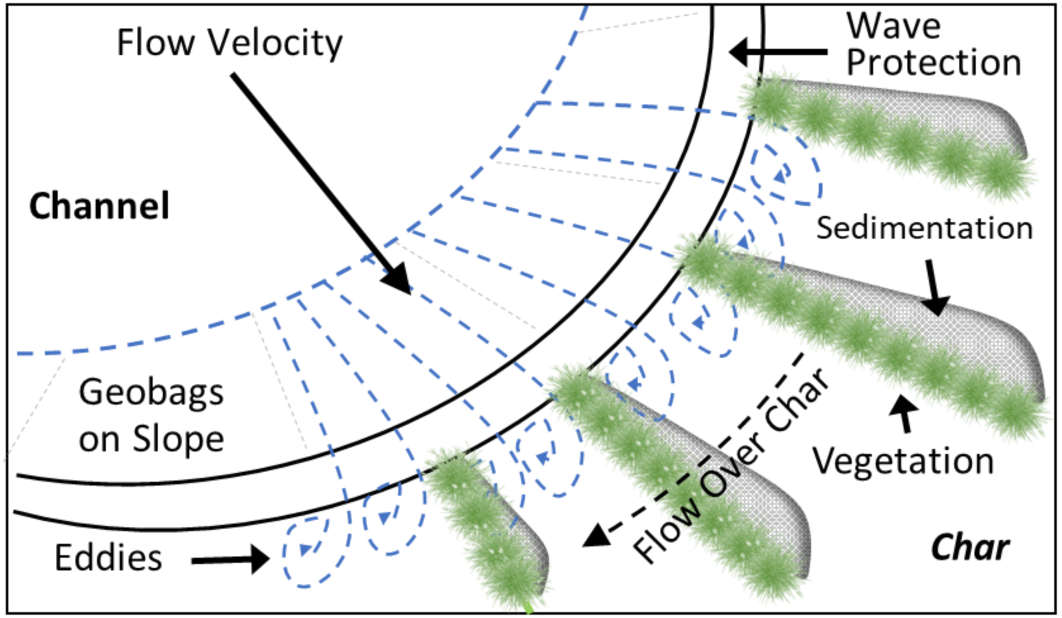
x = 12 cm above ground, y= 15 cm below ground

Infiltration in vetiver-planted sandy and clayey soils increased by 6% in 7 days and 16% in 35 days respectively compared to bare soil, demonstrating that vetiver promotes better soil water infiltration (Chowdhury et al., 2020).

Roughness Co-efficient of Vetiver-planted *Char* Soil



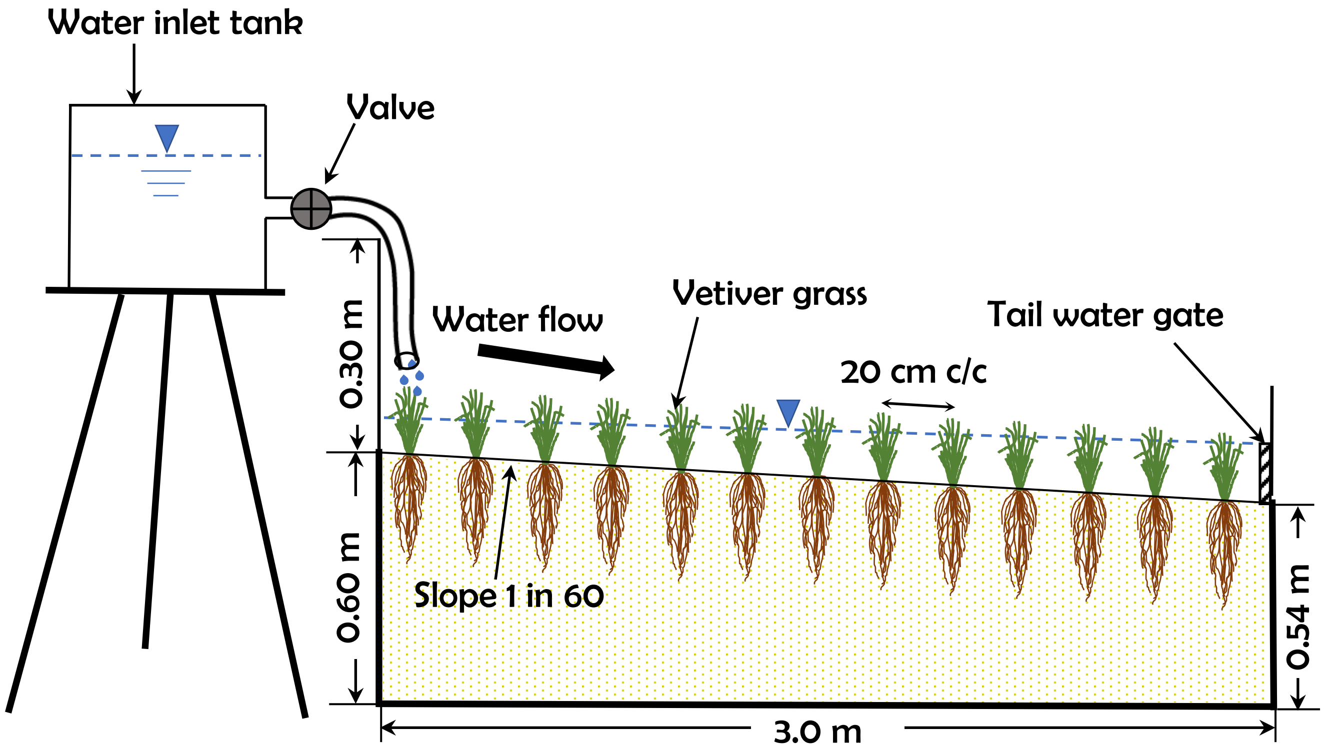
ADB, 2013



ADB, 2013

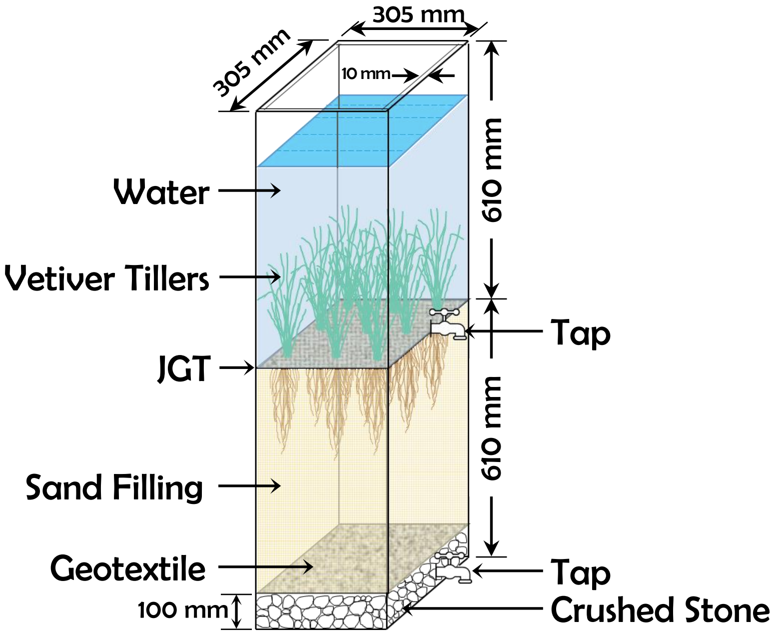
- About 60% of the *Chars* persist from 1-6 years, while about 15% have lasted for 12 years or more.
- Protection of *chars* from erosion and raising the *chars* through suitable bio-engineering measures (building with nature) can be a suitable option. Sedimentation will also improve the fertilization of the land.

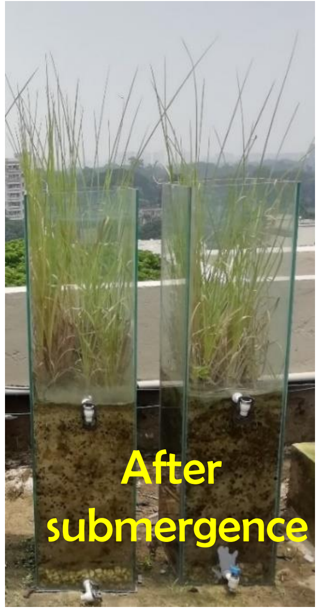
Roughness Co-efficient of Vetiver-planted *Char* Soil



The introduction of vetiver as a bio-engineering tool in sandy *chars* significantly decreases flow velocity, minimizing surface erosion and promoting land accretion, thereby offering an effective solution for the protection of these vulnerable areas (Islam and Sarker, 2022).

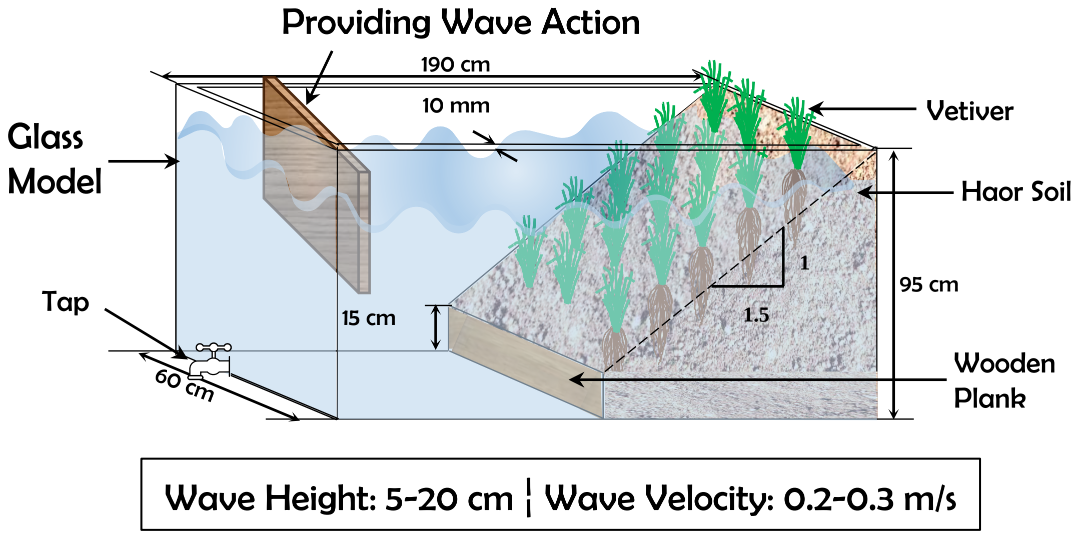
Submergence Tolerance of Vetiver

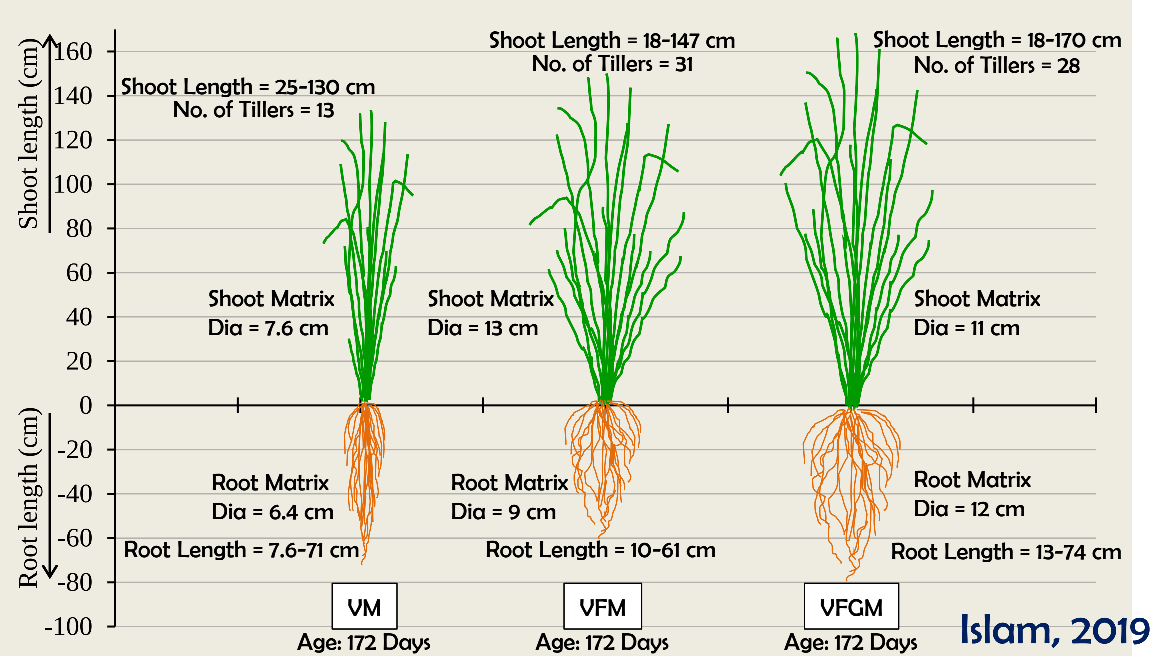




Vetiver grass can successfully survive under continuous submergence for 2 months, showing potential resilience against monsoon floods and flash floods respectively, making it a promising solution for the protection of submersible road and other haor infrastructure (Islam et al., 2022).

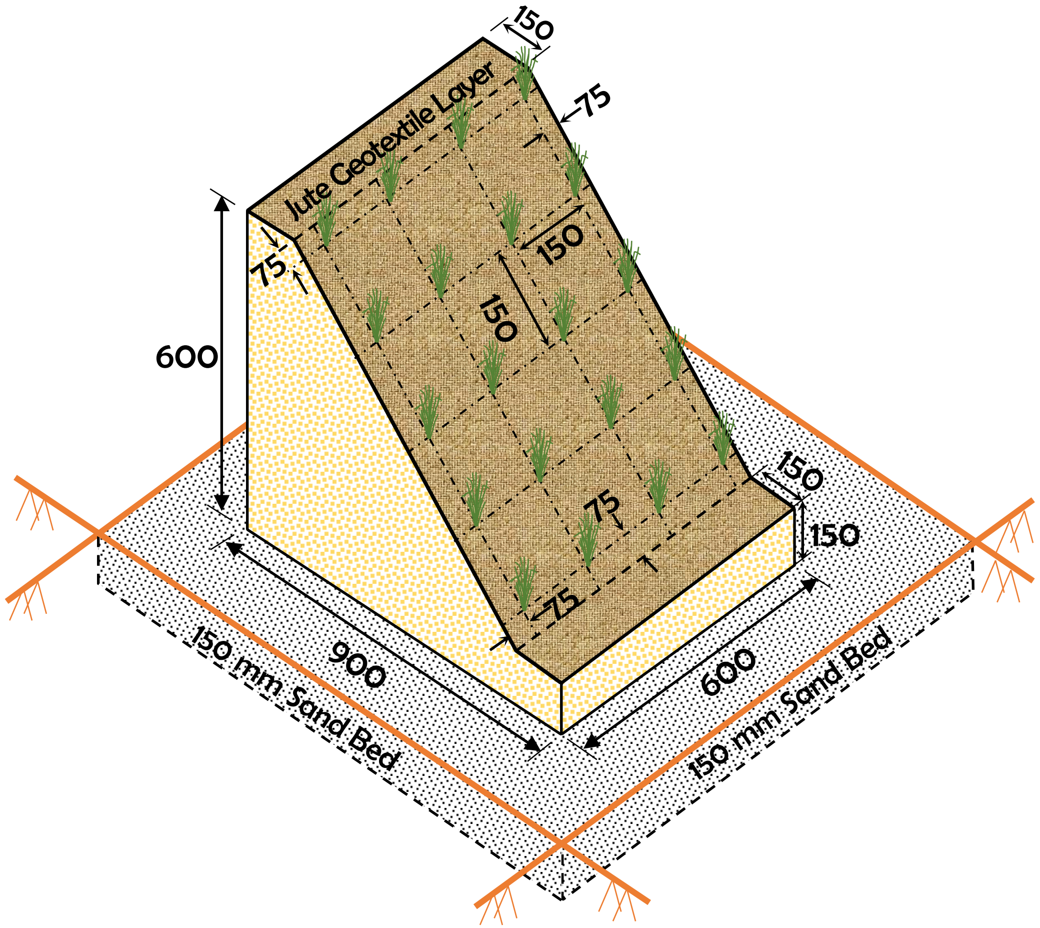
Wave Tolerance of Vetiver





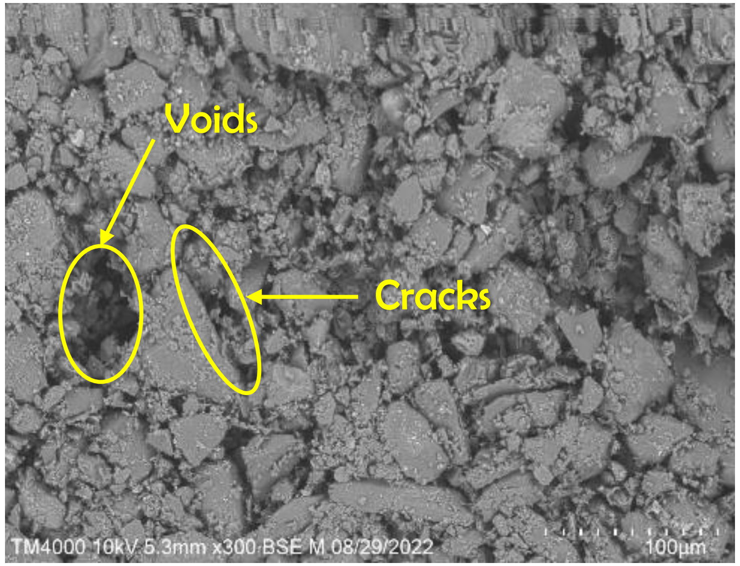
Slopes protected with vetiver grass, especially when combined with fly ash stabilization and jute geotextile (JGT), significantly increase wave tolerance and reduce soil loss, highlighting the effectiveness of these bio-engineering techniques in stabilizing soil and preventing erosion (Islam and Islam, 2022).

Erosion and Runoff Reduction



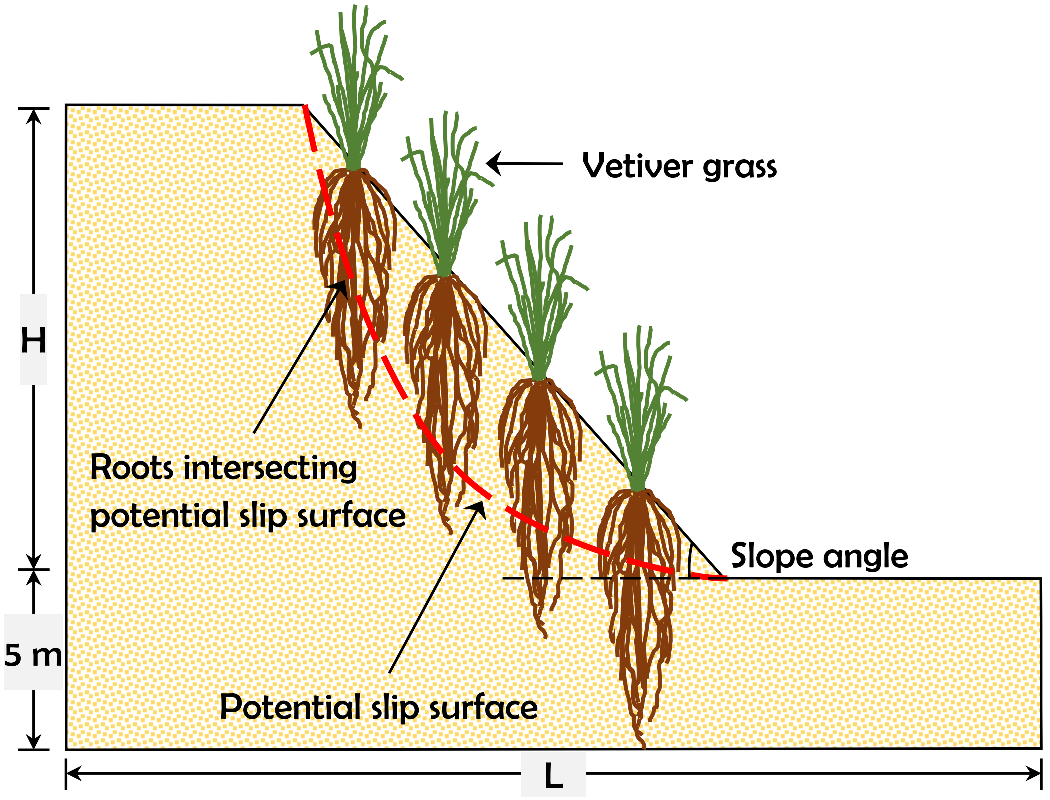
Vetiver grass significantly reduced soil loss by 94-97% and soil detachment rates by 95% in sandy silt under artificial heavy rainfall conditions, with a composite system of Vetiver and JGT proving most effective. Additionally, vetiver was more effective at reducing erosion and runoff in soils with a higher percentage of sand (Aziz and Islam, 2022a).

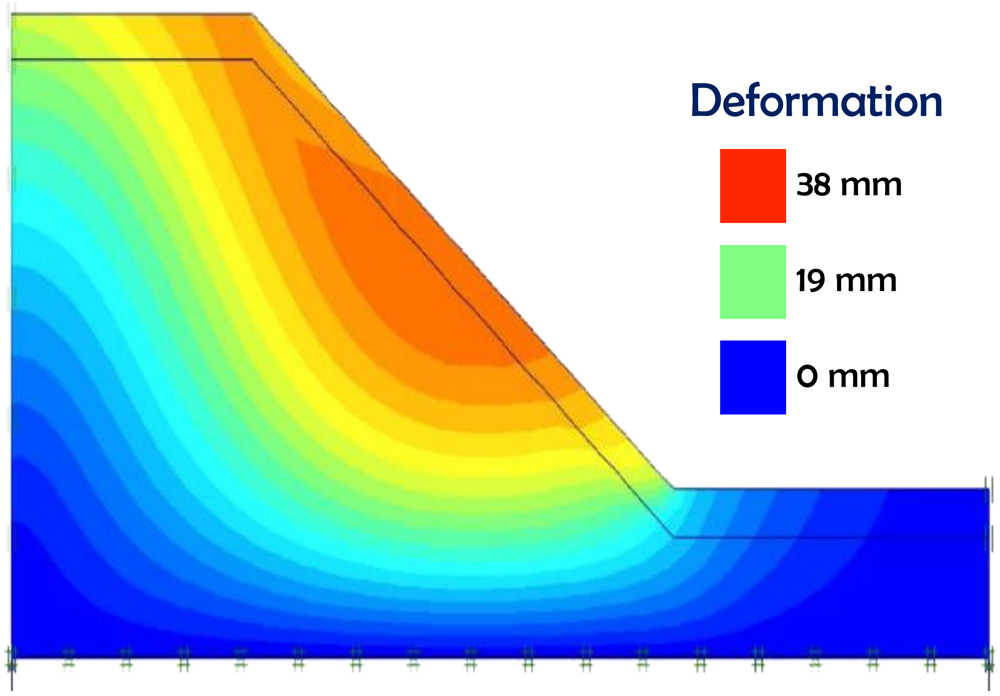
Vetiver Shoot Reinforced Earthen Block



Reinforcing earthen blocks with vetiver shoots increased their compressive strength by 40%, flexural strength by 15%, and ductility by 200%, demonstrating that vetiver shoot waste can be utilized effectively to improve the strength-ductility characteristics of earthen buildings (Islam et al., 2023).

Numerical Analysis



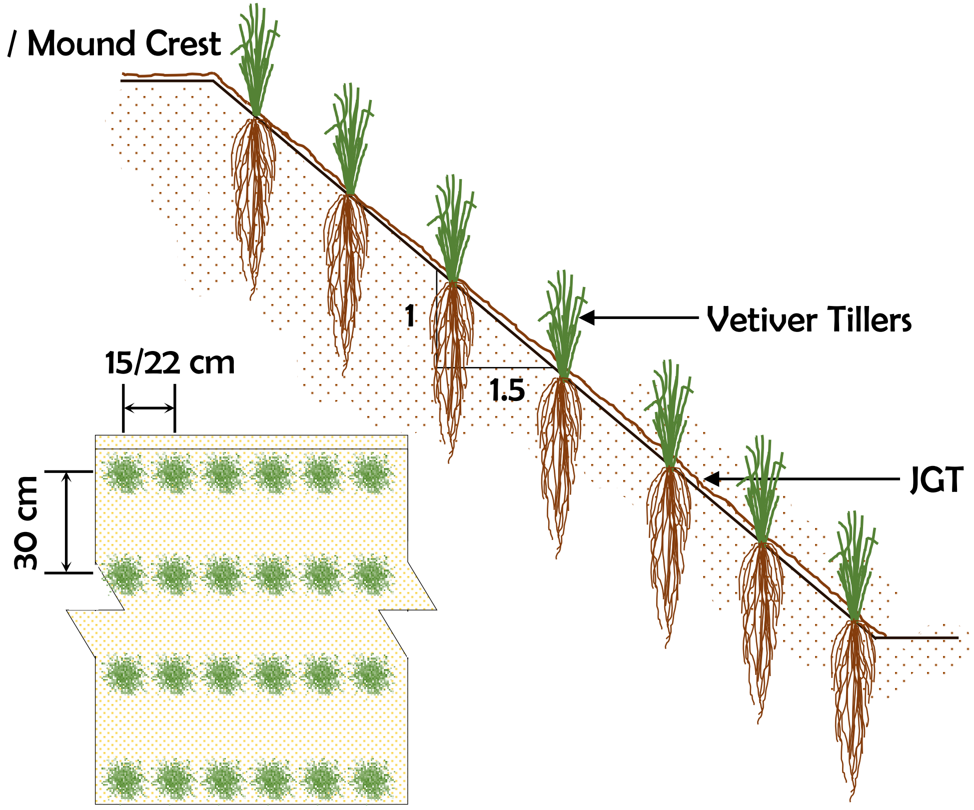


Vetiver root reinforcement significantly enhances the bearing capacity of ground and stabilizes embankment slopes. Due to vetiver root reinforcement, sandy hill slopes experience a 2-15% increase in the factor of safety, while the impact on clayey hill slopes was insignificant due to deep-seated base failure. Vetiver roots positively impact slope stability, particularly in sandy silt soils, with the combined effects of vetiver and terracing providing an increased factor of safety. Additionally, the combination of nailing and vegetation significantly enhances slope stability, notably in sandy soils, indicating their potential effectiveness for landslide prevention (Islam and Hossain, 2013; Islam, 2015; Elahi et al., 2019; Islam et al., 2020 and Aziz and Islam, 2022b).

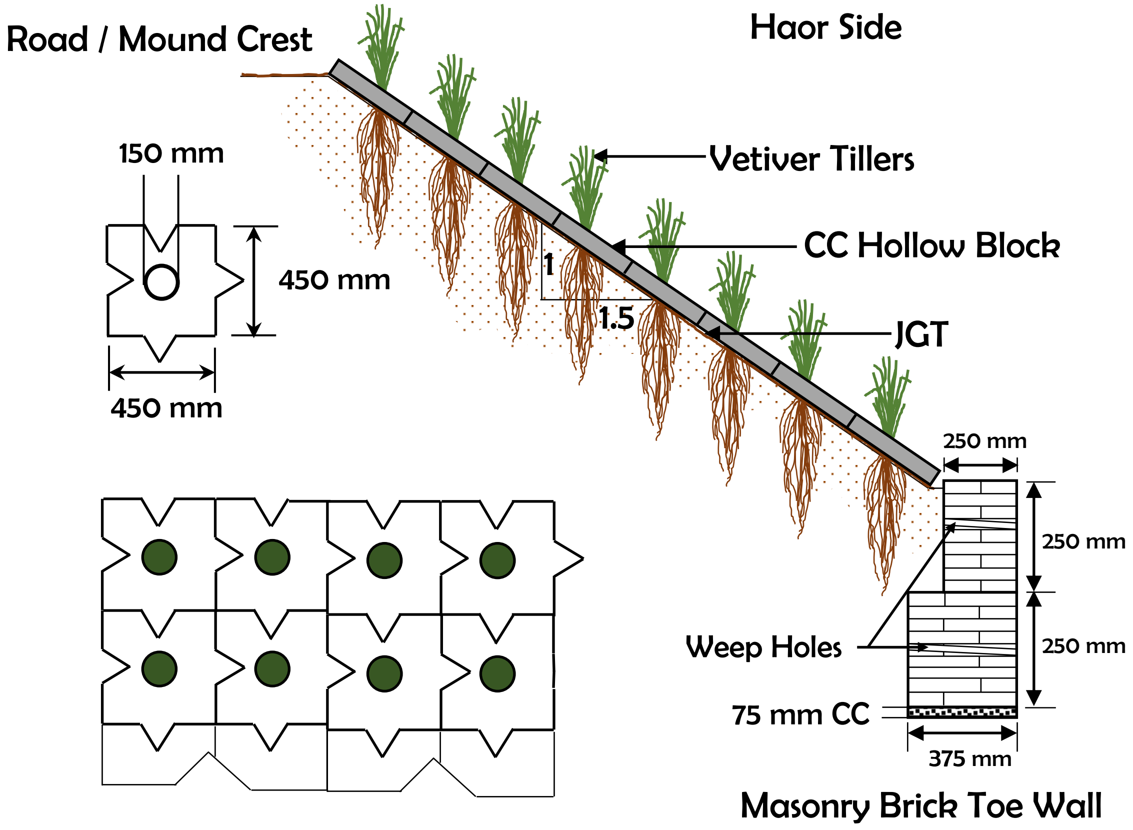
04

Field Piloting and Applications

VGT Schemes



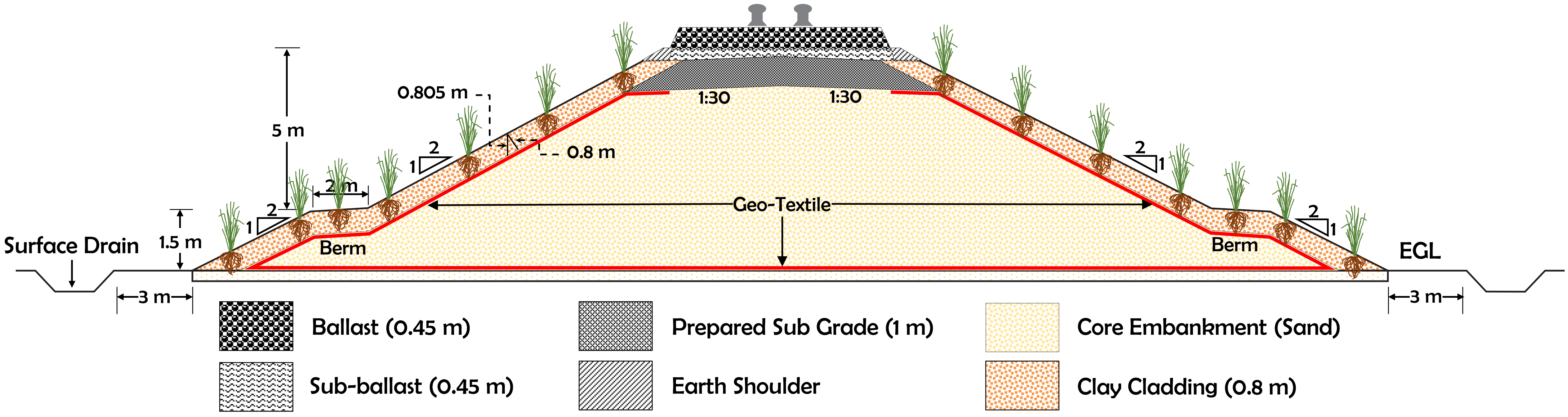
Type I/Type II

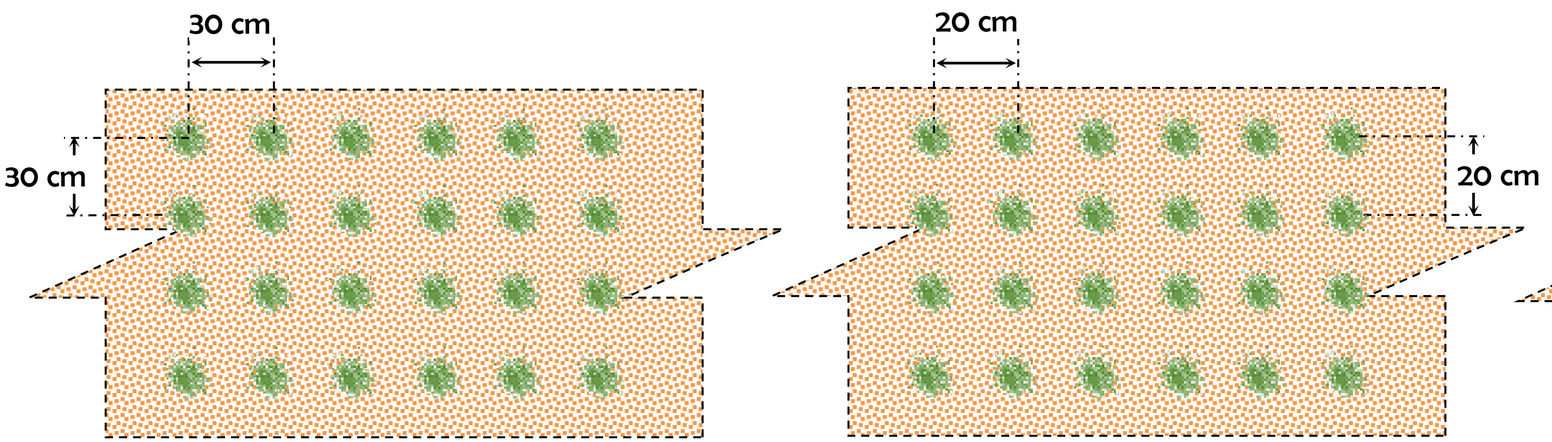


Type III

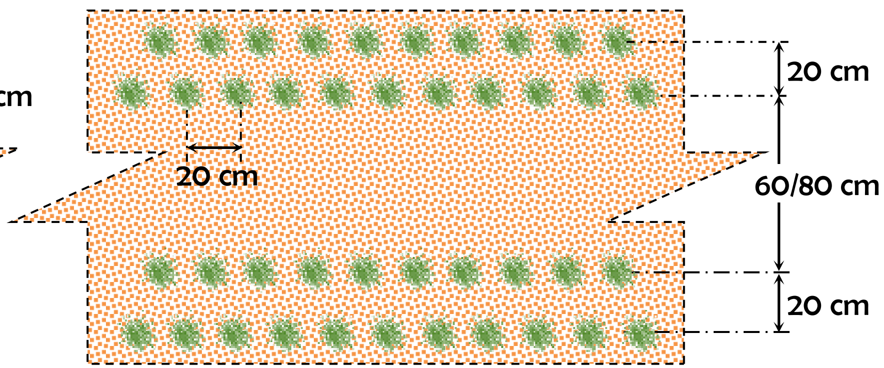
Islam, 2020a

VGT Schemes





Islam, 2021



Type IV

Rural Road Slope in Coastal Zone

LGED

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(a) village road slope protected by vetiver in a mid-saline zone, showcasing the effectiveness of vetiver against wave action and inundation during monsoon season; (b) union road featuring a steep embankment slope with soft clay; (c) union road with vetiver planted for embankment protection in a high saline zone, displaying satisfactory growth after 2 years and 3 months (Islam, 2020a).

Road Slopes in *Haor*

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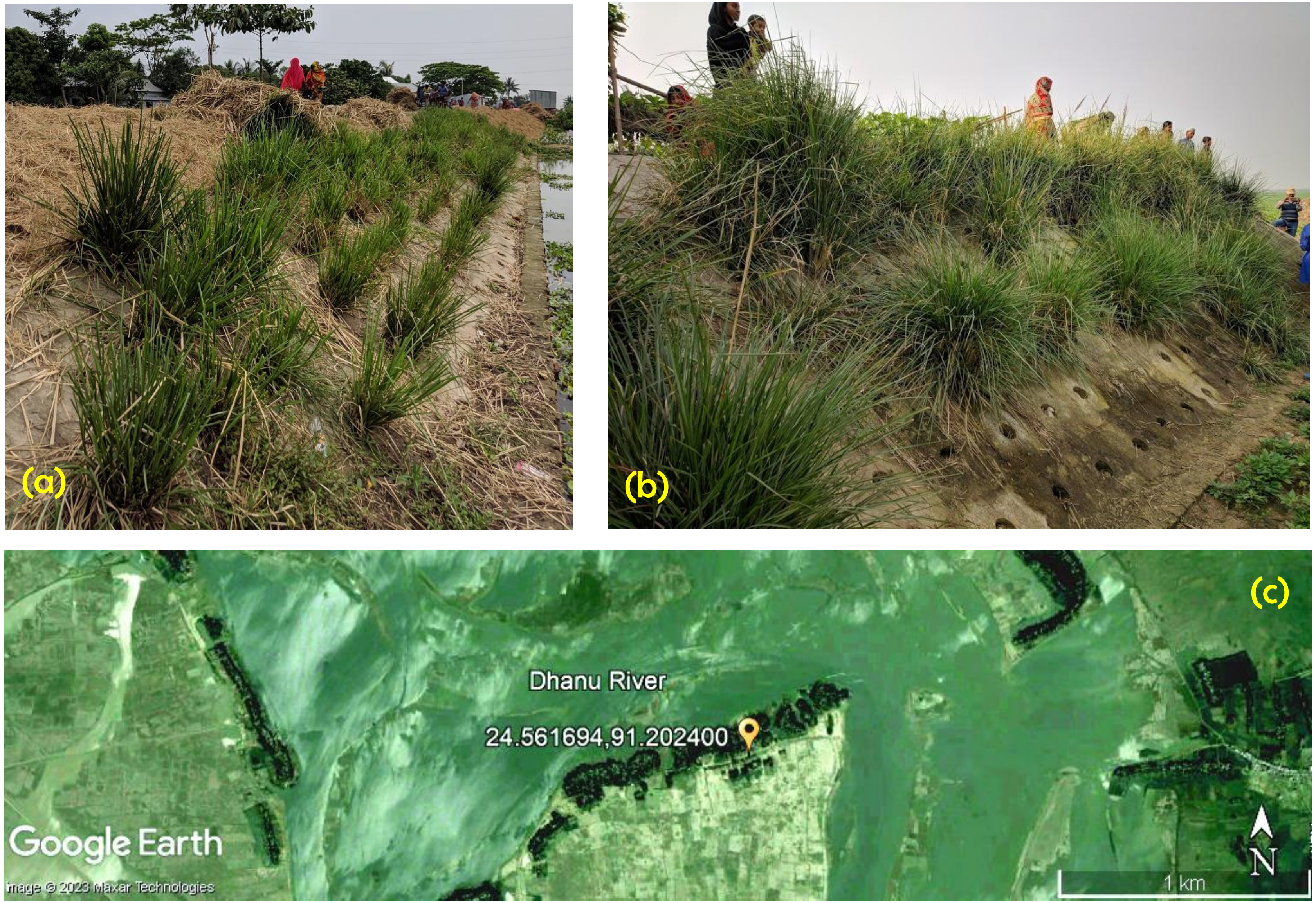
DEVELOPMENT

(a) VGT applied to a bridge approach road; (b) Side slope protection of a submersible road (which remains inundated every year for 4-6 months during monsoon) located in a *haor* area; (c) Steep slope protection using vetiver grass planted in hollow CC block (1000mm × 1000 mm × 100 mm with 75mm dia hole at the centre) holes where growth is hindered due to poor maintenance (Islam, 2020a).

Road Slopes in *Haor*



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(a) Road slope protection in deep *haor* with vetiver planted in CC block holes and toe walls where growth is hampered by dumped harvest remains and photograph is taken 11 months after plantation; (b) *Haor* village road slope protection using vetiver planted in CC block holes showing satisfactory performance in some points despite low maintenance and poor growth in lower rows about 3 years after plantation; (c) Google Earth Map illustrating the road slope site shown in (a) (Islam, 2020a).

Road Slope in *Haor*

LGED

Road slope protection in *haor* region: (a) Itna, Kishoreganj (deep *haor,* Type III), (b) Google Earth map showing the topography of the road site at Itna, Kishoreganj (the road is situated on the bank of the river, *Amader Nadi*) (Islam, 2020a).

Coastal Embankment

Coastal embankment protection using vetiver grass showcasing satisfactory growth in saline soil (EC= 9 microS/cm): (a) after 4 months of the plantation; (b) good maintenance practice, vetiver tillers are intentionally dumped at the slope to help conserve the soil moisture and to be utilized as organic fertilizer for better growth of vetiver; (c) shows the condition of the site after the cyclone Mocha held on May 9, 2023 (Islam, 2022).

Coastal Embankment

Flood embankment protection using vetiver grass in a *char* area, near Sandwip channel in the coastal zone, highlighting excellent growth.

Flood Embankment

(a) Flood embankment protection with vetiver grass demonstrating its submergence tolerance after surviving a two-week flash flood shortly after plantation; (b) Unaltered growth of vetiver grass, showing its survivability in flash flood conditions; (c) Brahmaputra flood plain embankment protection using vetiver grass exhibiting exemplary growth due to the nutrient-rich soil (Islam, 2022).

Rail Embankment

Assessment of vetiver grass effectiveness in protecting the clay cladding layer of a high rail embankment (up to 7m) in flood plain under Padma Bridge Rail Link Project (PBRLP), constructed with dredged sand (silty sand): (a) right after the plantation and (b) site condition after 6 weeks (Islam, 2021).

Riverbank

Successful survival of vetiver-based bioengineering technique for protecting riverbank, using vetiver and 500 gsm JGT through multiple monsoon seasons and a flood: (a) right after VGT application and (b) site condition after recession of 1st flood (Islam and Hoque, 2018).

Village *Killa* Protection

Successful performance of VGT for protecting *char* land using vetiver and 500 gsm JGT through multiple monsoon seasons (a) right after VGT application and (b) site condition after 1st monsoon (Islam and Hoque, 2018).

Village Killa/Island Protection

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(a) Protection of a village island slope using vetiver planted in CC Block (1000mm × 1000mm × 100mm with 75mm dia hole at the centre) holes near a waterbody, providing wave-breaking and anchoring effects despite poor maintenance; (b) Photo showing the Meghna Natunpara Village Island slope protected with vetiver planted in CC block holes after 2 years and 5 months of implementation, showcasing excellent growth and slope stability in a deep *haor* area facing significant wave action; (c) location of the site via Google Earth shown in (b), Meghna Natunpara Village Island (Islam, 2020a).

Hill Slope Protection

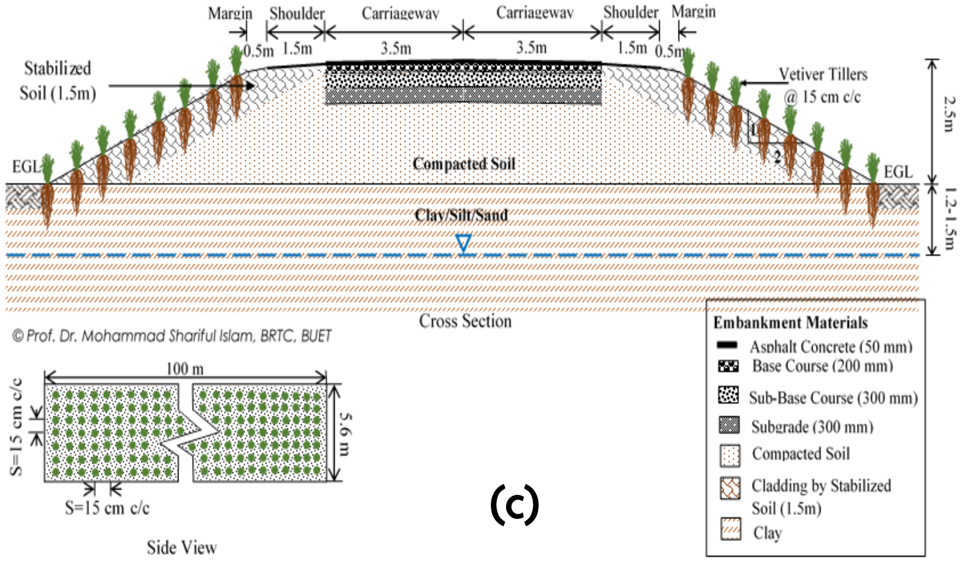
มูลนิธิชัยพัฒนา
The Chaipattana Foundation

(a) Nursery for Vetiver Demonstration Centre at Tigerpass, established by Chaipattana Foundation, Thailand and Chattogram City Corporation, Bangladesh, (b) piloted hill slope protection site with the experimental arrangements

VGT-based Projects in Different Geographical Locations

Sl. No	Project	Scheme	Infrastructure	Geographical Location	Soil Type	Disaster
1	HILIP	VG, VG+JGT, VG+ Hollow CC Block	Road, submersible road, village mound, *killa*	*Haor*	Sandy silt, silty sand	Flood, submergence, wave action, high rainfall
2	CCRIP	VG, VG+JGT	Road	Coastal zone	Soft clay, silty clay, silty sand	Salinity, tidal surge, flood, high rainfall
3	LoGIC	VG	Costal and flood embankment	Coastal zone, *char*, *haor*	Silty clay, silty sand	Salinity, tidal surge, flood, wave action, high rainfall
4	Eco-slope	VG+JGT	*Char* village, river bank	*Char*, river bank	Silty sand	Flood, river erosion, wave action, high rainfall
5	RHD	VG+JGT	Road	Rainfall, floodplain	Silty clay	Flood, high rainfall
6	BWDB and ECB	VG	Flood embankment	Coastal zone	Silty clay for cladding part and silty sand for embankment core	Salinity, tidal surge, flood, wave action, high rainfall
7	PBRLP	VG	Rail embankment	River floodplain	Clay as cladding and sand as embankment core	Flood, high rainfall
8	Hill Slope	VG, VG+JGT	Hill	Hilly	Variable layer of sand (top 0.06m), clay (next 0.9 m), silt (next 1.8 m)	High rainfall, landslide
9	Earthen Block	Vetiver shoot	Rural Earthen Building	*Barind* tract	Silt	Drought, earthquake, cold wave, storm

Global Projects-Road Slope Protection in Cambodia



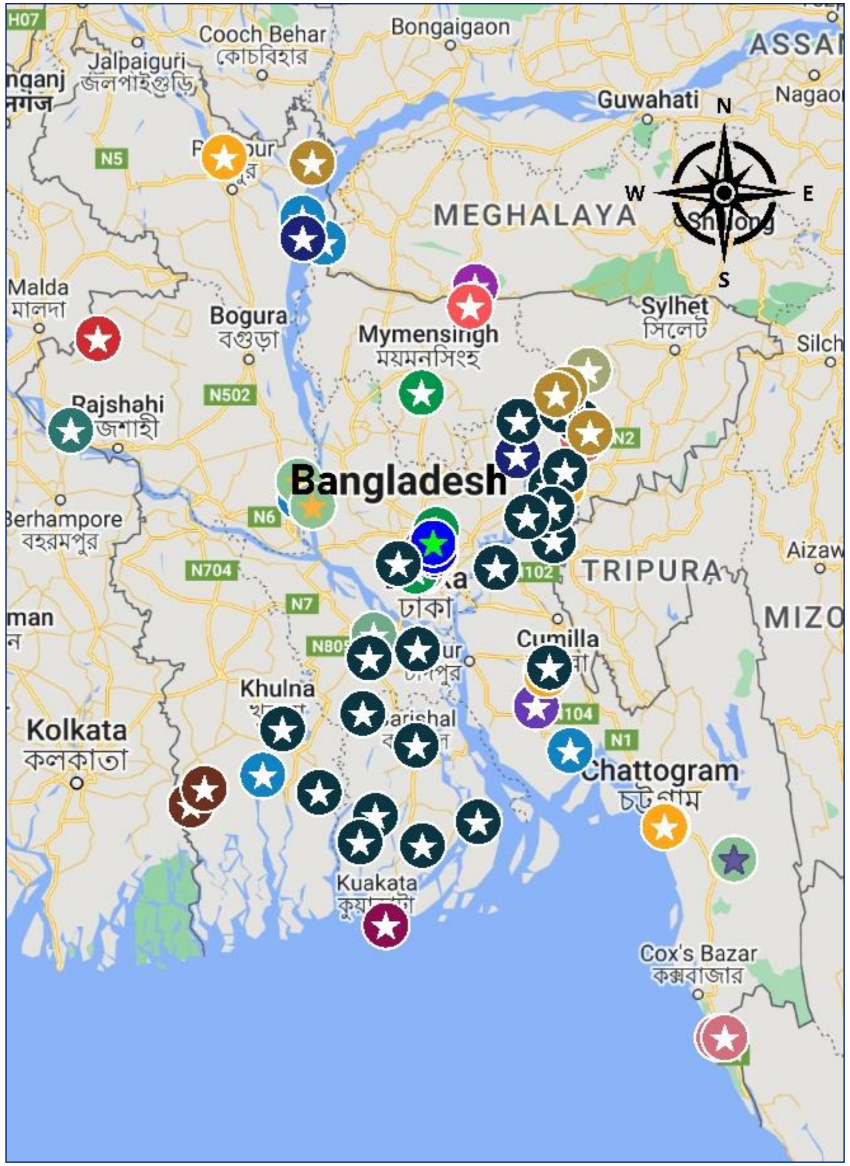
Condition of the roads before VGT application in (a) Prey Veng; (b) Kandal province; (c) designed VGT-based slope protection system.

It was proposed to stabilize the both sides (1.5m) of the embankment (cladding part) using a suitable catalyst depending on the embankment soil characteristics. After the construction of the embankment, turfing using vetiver grass is to be done for erosion control. Since in case of stabilized soil, the pH of the soil increases, vetiver grass is proposed for its adaptability of high pH range of 3.0 to 10.5. The combined method will reduce the cost for soil stabilization using catalysts up to 50-54% (Islam, 2020b).

Locations of Local and Global Projects

LEGENDS

- *Beel* Bank (1)
- Canal Bank (1)
- *Char* Land (2)
- Demonstration (3)
- Earthen Block (1)
- Flood Embankment (4)
- Growth Study (6)
- Hill Slope (2)
- In-situ Test (3)
- Village Island (5)
- Bandarban Hill Slope [Ongoing]
- ( )- Number of Observations
- *Killa* (3)
- Land Demarcation (2)
- Model Study (7)
- Natural Source (3)
- Nursery Demonstration (4)
- Pond Bank (1)
- Rail Embankment (1)
- Road Slope (23)
- Submersible Road (1)
- Lake Restoration (3) [Ongoing]
- Road Embankment in Cambodia [Ongoing]
- Road Embankment in Indonesia [Ongoing]



Locations of the model studies, field piloting and applications of 79 projects shown on the global map. Most of the completed and ongoing projects have been uploaded to the iNaturalist and many of the projects have also been uploaded to IVGT creating a knowledge base for VGT and a potential source of motivation for funding agencies.

05

Dissemination

Vetiver Demonstration Centre

มูลนิธิชัยพัฒนา
The Chaipattana Foundation

The main purpose of the Vetiver Demonstration Center is the awareness, motivation and training of various stakeholders and individuals.

Vetiver Model Site, BUET

High Officials of Royal Thai Embassy, Dhaka

Vetiver Model Site, BUET

High Officials of BUET

High Officials of LGED

High Officials of LGED and IFAD

Knowledge Sharing and Trainings

Media Coverage

Training Session with LGED

Seminar with RHD

Seminar at University

Workshop with Rural Community

Knowledge Sharing for Public Good

কালের কণ্ঠ

শনিবার ৩১ অক্টোবর ২০১৫

বিন্না ঘাসে বাংলার জয়

ভূমিকম্পরোধী বাড়ি বানাতেও কার্যকর ভেটিভার

জাদুর ঘাস

The Telegraph

GUWAHATI WEDNESDAY 23 NOVEMBER 2016 Rs 5.00, ALONG WITH Telekids Rs 6.50

Brahmaputra silt causes floods in neighbouring country, says conservationist

Bangla expert tips on river-bank erosion

AVISHEK SENGUPTA

Guwahati, Nov. 22: Bangladesh soil conservationist Mohammad Sariful Islam today extended his expertise to mitigate erosion of the Brahmaputra banks in Assam with a hope to address the flood problem in his country.

The Brahmaputra, which has its origin in Chemayungdung glacier in Tibet (where it is called Tsangpo) after passing through Arunachal Pradesh and Assam, enters Bangladesh to form the Brahmaputra-Ganga delta before meeting the Bay of Bengal.

"Because of massive erosion in Assam and upstream, the river brings lots of silt, which raises the riverbed resulting in massive floods in Bangladesh. If floods in my river-bank erosion need to be checked in Assam," Islam told **The Telegraph**.

Islam, a civil engineering professor of Bangladesh University of Engineering and Technology, was here to attend a two-day workshop on Application of Bio-Engineering Techniques for Mitigating River Bank Erosion organised by the Assam State Disaster Management Authority (ASDMA) that began here today.

The workshop delved in finding bio-engineering techniques, that is, the science of applying the concepts and methods of biology (and secondarily of physics, chemistry, mathematics and computer science) to solve real-world problems.

Islam had suggested scientific cultivation of a few select- river in the north Bangladesh districts on the Padma river, which had stopped river-bank erosion drastically.

"I have suggested a variety of grass called Binny *ghash* along the river beds. They are shrubs with sturdy stems and its roots spread far which hold the soil and stop it from eroding. To involve society, we have asked them to cultivate those plants along the river banks as the leaves are good fodder for cow, the sturdy stem acts as fence during floods to stop cattle from drifting away and the roots have medicinal values," the soil conservation expert said.

Islam's project is worth Bangladesh Taka 80,000.

Almost 80 per cent of Bangladesh is made up of flood-prone plains.

Islam is currently working ... tern and people's tendency to cultivate there. But a similar pattern of riverside plantation can be done here too to stop erosion. I feel experts from both the countries (India and Bangladesh) should chart a plan to stop erosion," Islam said.

Today's workshop was attended by Gearge Koshy, principal consultant, Earth and Water from Chennai, Hidetoshi Yokota, general manager from Bridgetone Corporation in Japan, Hemanta Hazarika, Kyushu University, Fukuoka, Japan, experts ...

জাদুর ঘাস

সমুদ্রপৃষ্ঠ থেকে বাংলাদেশের গড় উচ্চতা ১০০ ফুটেরও কম। বন্যা তাই নিত্যসঙ্গী। আর তা ঠেকাতে নদীর পাড় ও বেড়িবাঁধই সম্মুখসারির যোদ্ধা। চাইলেই কিন্তু একটি সবুজ ঘাস রোপণ করে আরো শক্তিশালী করা যায় ওই ঢাল। বিন্না নামের ওই ঘাস নিয়ে গবেষণা চলছে বুয়েটে। আদ্যোপান্ত জানাচ্ছেন জুবায়ের হোসেন ও ফাহমিদা হক

আনন্দ আলো

পরিবেশবান্ধব অবকাঠামো নির্মাণের উদ্যোক্তা শরীফুল

শাহ্ সিমেন্ট নির্মাণে আমি

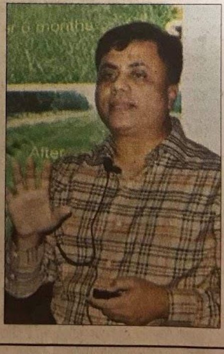
আনন্দ আলো — ২২ এপ্রিল, ২০২১ ১৫:২৬

বিন্না ঘাসের গল্প বললেন শরীফুল

দেশের বিভিন্ন এলাকায় ক্ষয়রোধে সফল বিন্না ঘাস বসবে চট্টগ্রামের পাহাড়ে

নিজস্ব প্রতিবেদক »

বিন্না ঘাস। এই দেশের গ্রামেগঞ্জে অহরহ দেখা যায়। পুকুর পাড়ে, পরিত্যক্ত জমিতে কিংবা চর এলাকায় লম্বা শিকড়ের গুচ্ছ আকৃতির মূলের এই ঘাস যে ইংরেজি ভাষার 'ভেটিবার' তা শনাক্ত করতে সময় লেগেছে আট মাস। এ বিন্না ঘাসেই বদলে যাবে দেশ। বন্ধ হবে ক্ষয় ও ভাঙ্গন। রাস্তার উভয়পাশে ভাঙ্গন রোধে এখন থেকে কম খরচের এই বিন্না ঘাস লাগানো হবে। ইতিমধ্যে স্থানীয় সরকার প্রকৌশল অধিদপ্তরের মাধ্যমে তা লাগানো শুরু হয়েছে এবং আসছে চট্টগ্রামের তিন পাহাড়েও। গতকাল সন্ধ্যায়



চট্টগ্রাম সিটি করপোরেশন ও ইঞ্জিনিয়ার্স ইনস্টিটিউশন অব বাংলাদেশ (আইইবি) আয়োজিত 'চট্টগ্রাম মহানগরীর জলাবদ্ধতা প্রশমনে বিন্না ঘাসের ভূমিকা' শীর্ষক সেমিনারে বাংলাদেশ প্রকৌশল ও প্রযুক্তি বিশ্ববিদ্যালয়ের পুরকৌশল বিভাগের অধ্যাপক ড. মোহাম্মদ শরীফুল ইসলাম বিন্না ঘাসের গল্প বলেন।

মূল প্রবন্ধকার হিসেবে ড. মোহাম্মদ শরীফুল ইসলাম তার বক্তব্যে বলেন, ২০০৭ সালের ১৫ নভেম্বর দেশের দক্ষিণ উপকূলে আঘাত করা ঘূর্ণিঝড় সিডর, উপকূলীয় এলাকায়

▶ ২য় পৃষ্ঠার ৭ম কলাম

সম্পাদক : রুশো মাহমুদ। সম্পাদক কর্তৃক সুপ্রভাত মিডিয়া লিমিটেড, ৪ সিডিএ বাণি...
সম্পাদকীয়, বার্তা ও বাণিজ্যিক কার্যালয় : প্রেস ক্লাব ভবন, ৬ষ্ঠ তলা, জামাল খান সড়ক, চট্টগ্রাম-৪...

Knowledge Dissemination

Seminar/Conference/Workshop	36 (Cambodia, Indonesia, India, Japan, Malaysia, Morocco, South Korea, Tunisia, Vietnam, USA)
Training of Trainers	5
Thesis Supervision	PhD-2, MSc Engg.-20, BSc Engg.- more than 15
ResearchGate	https://www.researchgate.net/profile/Mohammad_Islam28
Google Scholar	https://scholar.google.com/citations?user=eGsEQIMAAAAJ&hl=en
BUET Website	https://ce.buet.ac.bd/profile-of-mohammad-shariful-islam/
iNaturalist	https://www.inaturalist.org/observations?place_id=any&user_id=inatural-mohammad_shariful_islam&verifiable=any
iVGT	http://ivgt.ldd.go.th/vetivertrack/index.html

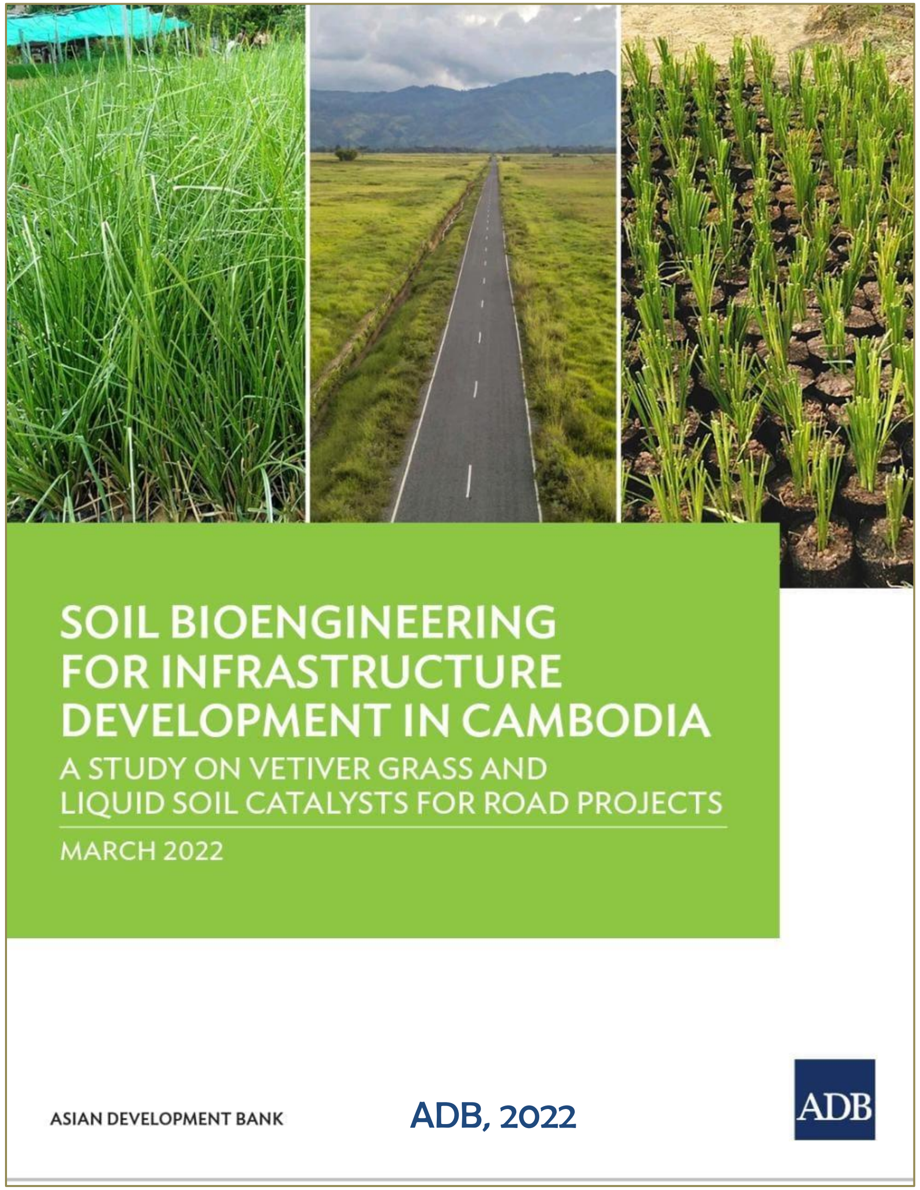
06

Knowledge Items

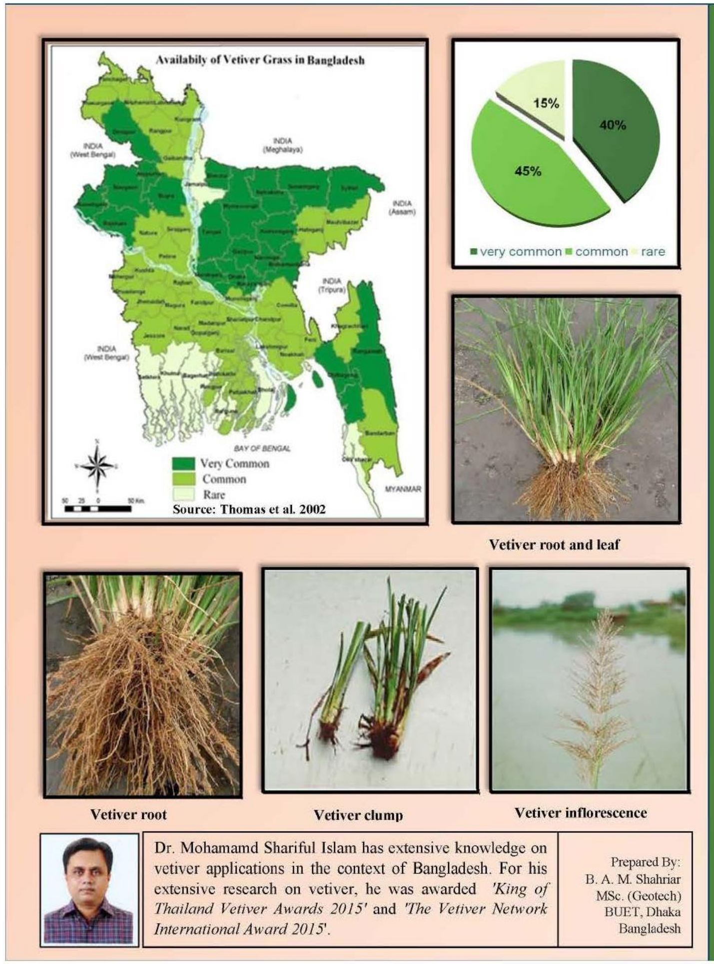
Knowledge Items

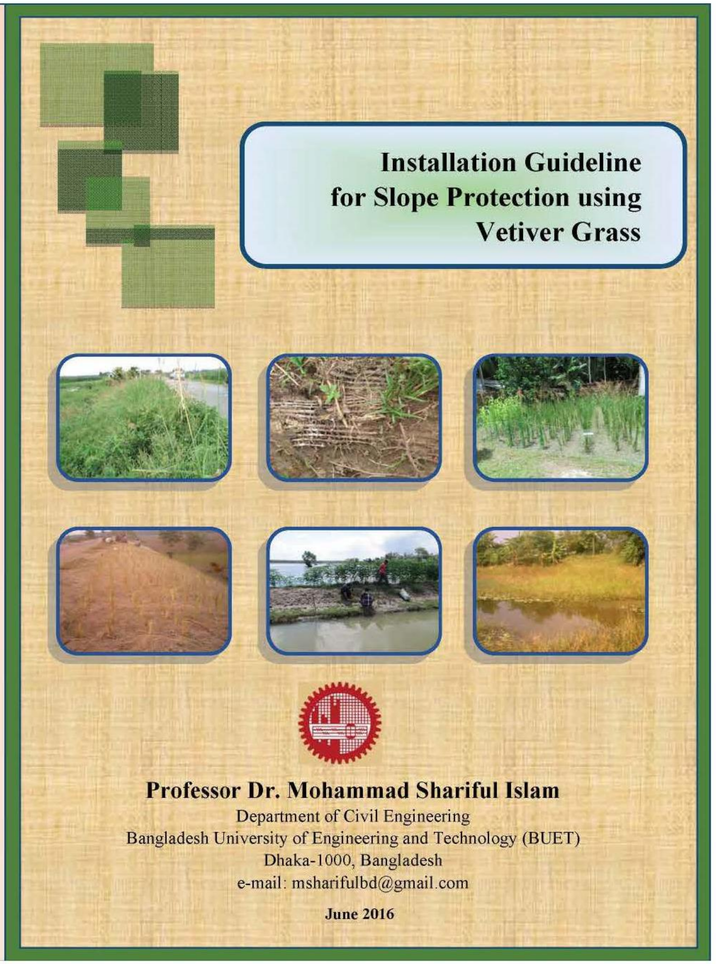
Book/Knowledge Product	03
Journal Papers	13
Refereed Proceedings	17
Conferences and Workshops	10
Reports	09
Norms and Specifications	01
Installation Guideline	02

Knowledge Items



ADB, 2022





07

Impacts and Influences

Impacts and Influences

- **Widespread Adoption of VGT**: Author's successful field trials has led to the application of VGT by various organizations and individuals, promoting job creation, entrepreneurship, and women empowerment.
- **Government Engagement**: Government departments in Bangladesh like LGED have incorporated VGT into their procurement schedules, reflecting its public sector recognition and acceptance.
- **Expansion of VGT works by Organizations**: Organizations are applying and scaling VGT in diverse scenarios, including *char* development and vetiver-latrine, using guidelines and specifications developed from the research.
- **Knowledge Dissemination**: The research outcomes have been shared through platforms like ResearchGate, Google Scholar, iNaturalist, iVGT, personal web profile in the university website expanding the knowledge base and promoting resource sharing among stakeholders.
- **Encouraging Collaborative Effort**: The work has influenced engineers, academicians, young scientists, communities and individuals for a collaborative effort to contribute to the achievement of SDGs through VGT.
- **Promotion**: Numerous government, non-government, funding agencies and international organizations are promoting VGT through their widespread applications. Author's supervisees, co-authors, colleagues are spreading VGT knowledge globally.
- **Recognition:** The research findings of the authors have been featured in local and international media and online portals. The author has received 7 international awards for exemplary VGT applications.

Regional Road-RHD

Roads and Highways Department (RHD) implemented VGT on 4 km long regional road slope with the cooperation of author.

ঢাকা টাইমস

বিন্না ঘাস: বাঁচিয়ে রাখবে ৫ লাখ রোহিঙ্গার জীবন

প্রকাশ | ১৯ জানুয়ারি ২০১৮, ০৯:৫৯ | আপডেট: ১৯ জানুয়ারি ২০১৮, ১০:১৯

মোহাম্মদ তালুত

আজকে খুব খুশি লাগছে। কেন, জানাই। কিছু ঘাস লাগিয়েছি। সামান্য কিছু। কিন্তু আসলে সামান্য না। এই তৃণ যে জীবনবৃক্ষ!

Hill Slope Protection at Rohingya Refugee Camp

IOM • OIM

Village *Killa*-Community People

Community-driven *killa* (village mound) protection in haor region: (a) Initially, LGED utilized allocated funds to safeguard two sides of the *killa* with CC blocks and witnessing the effectiveness of vetiver in slope protection in previous LGED projects, local residents were inspired to harvest vetiver in their own yards; (b) Afterward, they planted the yard vetiver to protect the remaining two sides of the *killa*, contributing to the community-driven effort which resulted in successful VGT application (Islam, 2020a).

Land Demarcation and Fencing- Community People

Land demarcation

Fencing

Cattle Fodder

Vetiver Nurseries

Uses of VGT-based NbS by Community and NGOs

CARITAS BANGLADESH

Secours Catholique
Caritas France

caritas
LUXEMBOURG

CRAterre
ENSAG

Local and International Agencies

Local	Implementing and Collaborating Agency	(BAPA) BANGLADESH PORIBESH ANDOLON; স্থানীয় সরকার বিভাগ-LGD; LGED
International	Implementing and Collaborating Agency	IOM • OIM; Save the Children; CRAterre
	Funding Agencies	ADB; Secours Catholique Caritas France; caritas LUXEMBOURG; CHAIPATTANA FOUNDATION; EU; IFAD INTERNATIONAL FUND FOR AGRICULTURAL DEVELPMENT; Sida; UNCDF; UNDP

08

Future Vision and Way Forward

Key Challenges

The key challenges encompass **physical, institutional and O&M barriers**. The challenges for local implementation of vetiver involve its adaptation to diverse environmental conditions, provision of specialized training, ensuring community participation, and developing appropriate maintenance guidelines. On a global scale, issues include limited awareness of vetiver's ecological benefits, the need for adequate data collection and appropriate reporting, creation of suitable contracting methods and establishment of standard specifications and norms.

Knowledge Gap: This includes the lack of knowledge, motivation, and awareness about VGT among engineers and local communities.

Community Engagement: This states the importance of prioritizing community-based projects to ensure local participation and benefits and the need for specialized training and suitable maintenance guidelines.

Standardization: It focuses on the need for more comprehensive standard guidelines, norms, and specifications for VGT, which should consider global and local perspectives.

Contracting Challenges: This includes the inadequacy of conventional contracting methods for VGT and the resulting reluctance among contractors and the need for a compatible contracting method.

Supply Chain Constraints: It addresses the supply chain issues and demand-supply imbalance and the need for proper linkages with entrepreneurs for timely application of VGT.

Future Vision and Way Forward

Knowledge Sharing and Training: It is important to share the existing knowledge among the practicing engineers and the local community and skill training for the proper implementation of VGT.

Community Engagement: It is needed to prioritize community-based projects for community participation and their benefits.

Standardization: This includes the necessity for more extensive standard guidelines, norms, and specifications that consider both the local and global perspectives in VGT usage in bioengineering projects.

E-marketing for Farmers: The potential of e-marketing as a platform for local farmers to sell vetiver tillers directly which requires support from government and private organizations.

Research and Development Funding: The role of government and influential individuals in allocating funds for R&D in VGT.

Multidisciplinary Collaboration: The need for cooperation between scientists, engineers, academicians, and government agencies for developing guidelines and construction methodologies.

Vetiver Institute: The importance of establishing a Vetiver Institute with experts from diverse fields for successful VGT implementation.

Future Vision and Way Forward

Vetiver Supply Chain: The essential development of a local vetiver supply chain, engaging small contractors, communities, and government, and leveraging e-marketing is required.

Community Development: This includes the role of VGT in improving quality of life of community, promoting handicrafts, and providing financial incentives and micro-credits.

Contracting and Quality Control: It includes the importance of specific contracting methods, procurement procedures, and quality control standards in VGT.

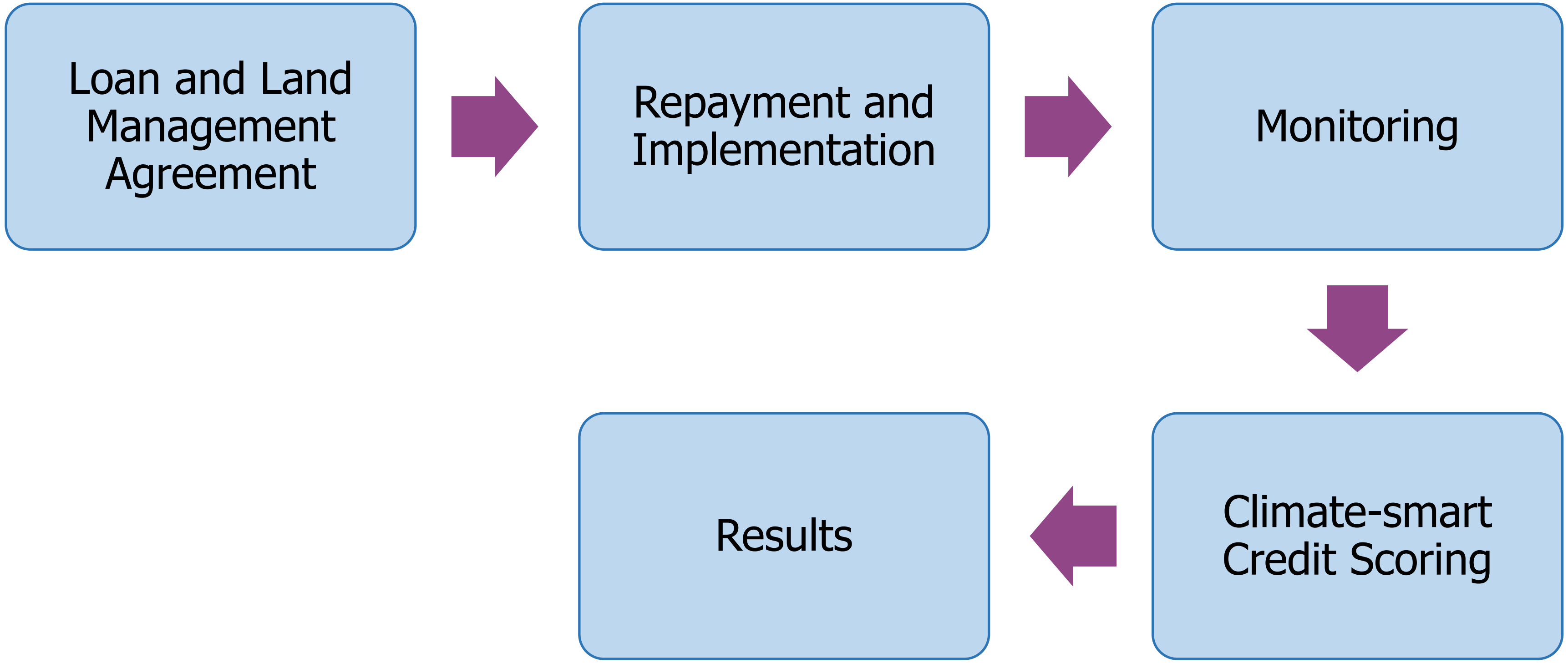
Climate-Smart Agriculture and Cross-Applications: It prioritizes climate-smart agriculture for conservation and promoting cross-applications of vetiver for broader adoption.

VGT Network and Sustainable Practices: It includes the establishment of VGT network in Bangladesh and the need for assessment of agricultural and industrial practices for sustainability.

Investment and Support: Vetiver contributes to carbon sequestration and it aligns with climate change adaptation and SDG achievement for potential international funding.

Climate-smart Credit

- Climate-smart credit incorporates climate-smart agricultural and land-management practices into loan terms.
- When a client signs a loan agreement, they also sign a land-management agreement which requires the client to manage their land in a way that is designed to protect them and their farm from climate-change related events.



Flow-chart for Climate Smart Credit (http://www.f3-life.com/climate-smart-credit.html)

09

Conclusions

Conclusions

- The research conducted over a decade by the author has found VGT to be effective in reducing disaster risk by stabilizing and protecting infrastructure. It's a potent solution to soil erosion, with successful implementation in diverse infrastructures and geo-environmental conditions in Bangladesh and around the world. However, significant research gaps persist, emphasizing the need for comprehensive design, construction processes, and contracting methods tailored to diverse soil and environmental conditions.
- The success of VGT is contingent upon overcoming challenges like the lack of awareness, knowledge, and motivation among engineers and local communities. Solutions include knowledge sharing, skill training, incorporating community-based activities, developing standard rates and schedules, devising efficient contracting methods, and establishing an e-marketing system to enhance supply chain effectiveness. Further, the allocation of more funds for research and interdisciplinary collaboration is critical for the advancement of VGT.
- Beyond its role in erosion control, VGT contributes to the Paris Agreement goals by reducing overall temperature through vetiver grass evapotranspiration and assists in carbon sequestration. VGT's benefits align with several SDGs, particularly SDG 9, 11, and 13. This evidence indicates that VGT can serve as an effective solution for climate change adaptation and thus, can secure relevant funds for VGT.
- The future of VGT relies on capacity building, integrated systems, and a comprehensive approach to address its challenges. The author believes that implementing his future visions will ensure scaling up of VGT for climate change adaptation, disaster mitigation, community development, and achieving public good and SDGs.

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Acknowledgement

The author acknowledges the infrastructural and financial support of Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh for carrying out the research work. The author is also grateful to different organizations namely BWDB, BR, CCC, ECB, LGED, LGD, RHD, MPWT-Cambodia, and DGH-Indonesia for providing necessary field support and ADB, EU, IFAD, SIDA, UNCDF, UNDP for providing the financial support. The author is also thankful to the BUET students who have participated and contributed in the different stages of the research and projects. He is also indebted to Dr. P. Truong and Mr. R. Grimshaw for their continuous support and encouragement for VGT research and application. The author is much obliged to Her Royal Highness Princess Maha Chakri Srindharn for her cooperation in establishing the Vetiver Center in Bangladesh.

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